THE

ELECTRICAL REVIEW.

VOL. L. FEBRUARY 28, 1902. No. 1,266.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1902 Edition

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CONVERSION OF OUR RAILWAYS.

WE have already referred to this most important question in our issues of January 24th and 31st, and we are obliged to return to the subject once more in connection with the paper on "Electrical Traction on Railways," which Messrs. Mordey and Jenkin recently read before the Institution of Civil Engineers. The fact that the question of adapting electric traction to railways is being taken up so vigorously, both before the Institutions and in the technical Press, augurs well for the prospects of the electrification of the suburban lines in our great cities. We ourselves have again and again preached the necessity of our railway companies at once taking in hand the electrification of their suburban lines, and we, therefore, welcome this paper in the hope that, if it does nothing more, it may at least impress upon the companies the necessity of doing *something*.

We must apply the same criticism to the paper in question, that we did to Mr. Langdon's paper before the Institution of Electrical Engineers, in November, 1900, and we much regret that the authors do not appear to have made any serious attempt to work out in detail a complete solution of a practical case, but have only considered approximations and thrown out hints as to what may be done in the dim future, instead of considering the important changes which should be at once taken in hand by our railway companies. The question is one which should receive very careful attention, and it is to be hoped that by the time the Metropolitan and Metropolitan District, have electrified their lines, the North London, the Great Eastern, the Tilbury and Southend, the South-Eastern and Chatham, the Brighton and South Coast, and many other railway companies, will be prepared to follow suit and equip their own suburban lines, using a system which offers facilities for interchange of traffic, equal to that which obtains at the present day.

Messrs. Mordey and Jenkin's paper can be divided into two sections, the first of which is a compilation, and contains nothing which is not known to everyone who is interested in electric traction; a large number of the figures and the descriptions there given, have evidently been taken from the evidence given at the recent arbitration.

The second part of the paper is more or less original, and seems to embody the ideas which the authors think should be adopted in the near future by our railways. This portion is, we think, open to serious criticism, and we very much doubt if any engineers who have really had much experience in traction work and who are acquainted with what has been, and is being, done in various parts of the world, would endorse the methods proposed in the paper for solving the problem of electric traction on our railways. The authors attempt to show that their system is the best, by a set of conditions which they state must be complied with by any system before it can hope to be adopted with satisfactory results. According to them, these conditions can only be fulfilled by a

modification of a very old and well-worn system, which was, we think, first proposed by Major Cardew in some lectures which he gave in the early eighties. Variations of this system have been brought out from time to time, notably by Mr. Heilmann in France, and Mr. Ward Leonard in America, but in no case have they proved successful. It would appear that the Maschinenfabrik Oerlikon is now experimenting with a similar system. It is evidently very hard for Mr. Mordey to leave his old love, and he has once more returned to the use of the single-phase alternating current. The authors seem to find no difference between electric railways and electric tramways—presumably they are in this case referring to light railways, otherwise their supposition would certainly seem surprising, as they would be comparing, say, the Central London Railway with its 140-ton trains and the London United Tramways and its 12-ton cars.

Since the arbitration, many engineers seem to be imbued with the idea that nothing but bare conductors carrying currents at pressures of thousands instead of hundreds of volts can be satisfactory for traction on railways. We do not think that such an idea is justified by past experience, at any rate as regards suburban lines, although we fully endorse the advisability of generating and transmitting the energy at a high pressure from as few power stations as possible.

It is stated that the three-wire system failed in America and was successful in England. This is perfectly correct, but at the same time it is misleading, because in the case of the American lines, owing to the absence of sub-stations, it was considered to be too costly to add equalisers. Furthermore, the system was adopted on tramways, and in that case it is very much more difficult to balance the number of cars on each side of the neutral than with an electric railway, where trains run much more regularly and to time table. The City and South London is, however, a very bright example of what English engineers and manufacturers can produce, and we are proud of the fact that it and the Liverpool Overhead Railway were the first railways to be operated electrically in any country.

We doubt whether the authors are quite justified in the statement that it is an open question whether it is not better to use motor-generators than rotary converters for traction purposes. We believe that very few traction engineers will be found to question the absolute superiority of the rotary converter. It is not casting any reflection on those who have not had the opportunity of having a very large and practical experience with a comparatively new type of apparatus, for us to consider their judgment of but little value as compared with that of men who have. It is evident that the prejudice against the rotary converter, which is often exhibited, is due either to interested manufacturers who have not had experience in constructing such machinery, or to people who have little familiarity with the operation of the apparatus, or have, unfortunately, had to do with defectively designed or constructed samples.

In a table which the authors give in the appendix, where they have calculated the watt-hours per ton-mile on the Central London Railway, we find two figures which entirely disagree with the sworn evidence at the arbitration. The output per ton-mile is stated by the authors to be 102 watt-hours at the main station, or 95 watt-hours at the sub-station, whereas Mr. Chapman in his evidence stated that it was only 41½ watt-hours on this line, and in experiments he had carried out at Chicago it was 60 watt-hours, whilst in the tests made by Messrs. Chapman, Dawson and Parshall at Sondrio on the Ganz system the watt-hours per ton-mile averaged from 60 to 80. We imagine that the authors have overlooked the fact that both the lighting and the lifts in the Central London Railway are operated electrically, and we are informed that a fair estimate of the percentage of power used by the trains is 50 per cent., the lifts and lighting taking from 30 to 40, whilst the remainder is accounted for by losses in transmission, &c. An oversight like this, if not noticed, might cause serious mistakes to be made as regards the economy of electric traction, since it is evident that on a surface line without lifts or lighting the watt-hours per ton-mile given by the authors for the Central London Railway would be misleading.

The authors give the cost per passenger carried on the Central London Railway and the City and South London Railway, much to the advantage of the latter. No mention, however, is made that the greater portion of this difference is due to the bad condition of the track and to the very heavy direct-connected motors on the Central London Railway locomotives. If this fact is taken into consideration, and the other charges, which are greater in one case than in the other, but which are not due to system, are equalised, the Central London Railway will come out better than the City and South London.

In the case of transforming stations, we think the authors have not had access to the latest figures; they also do not state what they mean by a "fair proportion" of spare plant, and hence the tables they give are of little real use. Supposing that they have allowed for 25 per cent. of the total equipment as spares (and this is a fairly liberal allowance) their figures for the cost of rotary converters and motor-generators are about 12 per cent. and 40 per cent. too high respectively, whilst the cost of transformers is nearly 18 per cent. in excess of present prices for similar apparatus.

The authors consider that steel rails have about ten times the resistance of commercial copper—we think this a rather low estimate; the figure is nearer 11, and often reaches 12, although where rails of proper composition are specially rolled for third-rail purposes, the resistance can be brought down so as to be only between seven and eight times that of commercial copper. The advantage claimed for alternating current, that there is no electrolysis, is a very doubtful one, and will, we think, be denied by many authorities.

The whole question of the cost of installation of direct *versus* alternating current railways is not properly brought out. In the arbitration it was contended by several experienced witnesses that the reduced cost of working conductors, owing to the high pressure used, and the omission of the rotary converters, would not greatly decrease the cost of one system, as compared with the other, owing to the low power factor, which may often be as low as 0·7, necessitating much heavier feeders and larger generators and transformers.

The authors give 12 conditions which any electric system must fulfil, and this question is of sufficient interest to be considered more at length. These conditions are as follows:—

1. For main lines an extra high pressure supply must be used for feeding the sub-stations placed along the line.
2. These sub-stations must not contain any moving machinery, so that there need be no constant attendance or supervision.
3. For main lines, or for lines more than about 50 miles in length, which run into the country, some form of high or extra high pressure supply must be adopted for distributing the power from the sub-stations to the trains.
4. With a high pressure distributing system, overhead conductors must be used in order to make them inaccessible.
5. The overhead distributing system should admit of unlimited extension and be such as could be adopted as a standard by all railway companies, for it is nearly as important that the overhead equipment should be the same on all railways, as it is that they should have the same rail gauge.
6. The overhead distributing system should be able to supply energy to trains with different types of motors and systems of controlling them.
7. A high acceleration must be possible when starting the train.
8. On a falling gradient, or when stopping, the energy of the moving train should, if possible, be returned to the line.
9. It should be possible to vary the speed economically within wide ranges to admit of running on suburban lines, and on main lines with the same train equipment, and to enable lost time to be made up.
10. The motors should form, or should be combined with, a variable ratio arrangement for starting, for speed regulation, and for returning energy.
11. It should be possible, either to have all the motors on a locomotive, or to distribute them throughout the train.
12. The train equipment and control should admit of unlimited extension, and should be capable of modification, so as to work with other distributing systems than its own.

With the first four of these points we are more or less in agreement, having, indeed, ourselves enunciated them for main line working in December, 1900. There is, however, some question as to the practicability of overhead conductors for large powers and high speeds. Under these conditions the overhead system has proved a failure in America, and has had to be discarded even where only one conductor has been used.

On the Baltimore and Ohio Railway, where a solid overhead conductor was employed, it has had to be pulled down and replaced by a third rail. We doubt whether the Board of Trade would allow high-pressure bare wires over the centre of the tracks. In the Berlin-Zossen experiments these high-pressure wires have had to be placed at the side of the track. If such an arrangement were adopted, it would entail considerable complication at junctions and crossings.

If the authors' remarks in section 7 had applied to suburban traffic, we would have fully agreed with them; but if they apply to long-distance lines, we see no object in a high rate of acceleration.

The system worked out by the authors, although containing some novel features, is not in itself new. It consists in having a single-phase motor coupled to a generator and exciter on the locomotive, from whence other continuous or three-phase currents can be sent to the motors which drive the train. By this means any combination is possible, but at the same time it must not be overlooked that it means that then every train must carry treble the amount of machinery, which would otherwise be necessary. Thus a train which is equipped with, say, six motors rated at 250 H.P. each, would have to carry, in addition, a 1,500-H.P. generator, driven by a 1,500-H.P. motor.

It is true that on some railways several tons of cast-iron or old rails are added to each coach, so as to increase stability, but the authors presumably do not suggest to put in a motor-generator in each carriage, which, although it might supply additional weight necessary to secure easy running, would be very costly as compared with pig iron or old rails, not to mention the space which would be taken up by the additional motor-generator plant. Should this be their idea, it must be borne in mind that the machinery on each carriage is tripled, as well as the capital expenditure and cost of maintenance. If the authors do not suggest this method, we cannot see that by adding a motor-generator in a locomotive at one end of the train they will give additional stability to the ordinary passenger carriages.

In conclusion, we would say that the paper is from a certain point of view of interest, and will undoubtedly give rise to a very good discussion, but it does not present any information which will be of benefit to those who are considering or are engaged in the construction of electric lines.

THE ELECTRICAL CONDUCTIVITY AND MAGNETIC PROPERTIES OF ALLOYS OF IRON.

The investigation of the electrical, magnetic and mechanical properties of alloys has hitherto fallen in a great measure to German metallurgists; it was one of the first pieces of work undertaken by the Charlottenburg National Physical Laboratory. An account of the researches is published in *Band II of the Wissenschaftliche Abhandlungen der Physik. Tech. Reichsanstalt*, of which we gave a summary in the Electrical Review, April 22nd and May 6th, 1898. It is with great satisfaction that we note that British metallurgists have now awakened to a sense of the importance of this question. Mr. R. A. Hadfield, of the Hecla Steel Works, Sheffield, in association with Prof. W. F. Barrett and Mr. W. Brown, of the Royal College of Science for Ireland, have prepared and examined a great variety of different alloys of iron, and we venture to think that their paper read before the Institution of Electrical Engineers last week is the most valuable contribution to the subject which has appeared in this country. It lacks only one thing, so far as we can see, and that is an account of the enduring qualities of the alloys under varying conditions of dampness and temperature; we hope that before the specimens are put aside the authors may be able to complete their investigation on that essential quality—the permanence. The paper is too long for full publication here; it has, therefore, to appear as an abstract.

In the preparation of these specimens a great variety of different alloys of iron were made and cast into ingots. Many of these, after examination, were rejected, owing to the difficulty of getting good castings, or the impossibility of forging and then rolling the specimens. There remained 110, which were forged into bars, and these bars, after being heated to a bright red (about 900° C.), were rolled into rods of nearly circular cross-section, about ½ centimetre (0·2 in.) in diameter (No. 5 B.W.G.), and cut into lengths of 106 cms. (42 in.). After being straightened, the rods were tested for electrical conductivity, and many of them for magnetic permeability, in the ordinary rolled or unannealed condition. The rods were then very carefully annealed, being heated to about 1,000° C., the cooling (in an E. and W. position) taking 100 hours, about four days and nights, and the electrical conductivity and the magnetic properties of the whole series carefully redetermined in this annealed condition. After further tests on other physical properties of these alloys in their present annealed condition have been concluded, it is proposed to repeat the experiments on the rods when hardened.

The specimens tested in the form of rods and wires were—

Class 1.—Alloys of iron containing varying proportions of *one* other element	59	specimens.
„ 2.—Ditto, ditto, *two* other elements	44	„
„ 3.—Ditto, ditto, *three or more* elements ...	7	„

A chemical analysis of each of these alloys is given in the paper. The paper is divided into four parts. Part I. deals with the electric conductivity of the alloys; Part II. with their magnetic properties; Part III. describes a series of practically non-magnetic alloys of iron; and Part IV. gives the results obtained with two alloys containing nearly 3 per cent. of non-magnetic elements, which, nevertheless, are, within certain wide limits of induction, more magnetic than the purest commercial iron obtainable (Swedish charcoal iron, containing 99·89 per cent. of iron), all being in the same physical state as regards annealing. The conductivity of the rods was determined by the potential method, the fall of potential over a known length of the rod under experiment being compared with the fall over a corresponding length of a standard copper or iron rod.

Fig. 1 shows the electric conductivity, and fig. 2 the specific electric resistance of those alloys of iron contained in Class I. In fig. 1 the ordinates express the conductivity, Matthiessen's pure hard copper being taken as 100, and the abscissæ give the percentage of the other elements alloyed with the iron. In fig. 2 the abscissæ are the same, but the ordinates express the specific resistance in microhms per c.c. As it is impossible to represent by diagrams on a plane surface the results obtained with varying percentages of two or more elements added to iron, the results are shown in tabular form in the paper.

The standard with which the conductivity of the rods was compared was a specimen of pure copper obtained from Kelvin and White, of Glasgow; the conductivity of this standard had been determined with care in the Physical Laboratory of Glasgow University and found to be 101·01, Matthiessen's hard-drawn pure copper standard being taken as 100. In addition to the foregoing, a standard was made of the purest commercial iron in the form of a rod 104 cms. long, carefully turned to a uniform diameter throughout its length; the sectional area of the rod being 0·1874 sq. cms., about the same as the rest of the specimens. A sample of this standard iron was drawn into wire of the same diameter as the copper standard (0·124 cm.), and the relative conductivity of the iron and copper wires directly determined, and also their specific resistances per c.c. The specific resistance was found to be 10·47

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microhms per c.c. for the iron wire, and 1·721 for the copper, both at 18° C. The conductivity of the iron deduced from these values is 16·44. Comparing the conductivity of the standard iron *rod* with the iron *wire*, the former was found to be 16·5 and the latter 16·4, Matthiessen's copper being taken as 100; this slight difference between the iron rod and iron wire being due to some variation in hardness in the two specimens, which had not been specially annealed. When the wire was carefully annealed its conductivity rose to 16·78; copper, as before, being 100.

Hence, by multiplying the conductivity of any specimen, in terms of *copper*, by 100, and dividing by 16·78, we obtain the conductivity

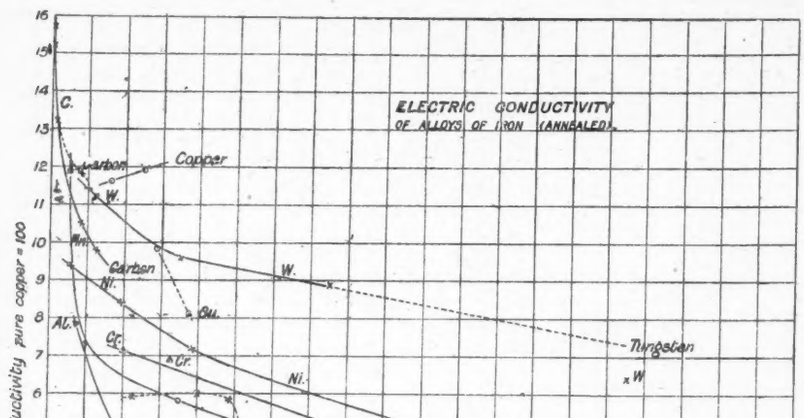

Fig. 1.

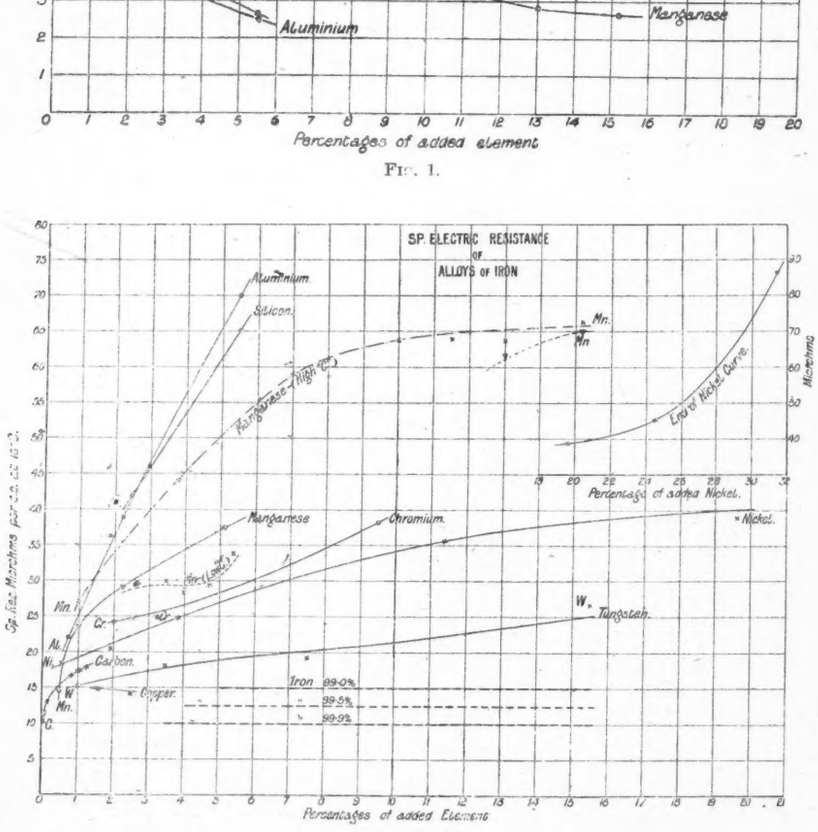

Fig. 2.

in terms of the standard *annealed iron as* 100. As, however, it is often more convenient to express the results as resistances, we can find the *specific resistance of any specimen* in microhms per c.c. by multiplying the specific resistance of the standard copper (1·721) by 100 and dividing by the conductivity of the specimen in terms of copper, the ratio of the respective resistances being inversely as the ratio of their conductivities. The temperature throughout was that of the air, about 18° C. Notwithstanding the care taken in the manufacture of these alloys to reduce the impurities to a minimum, a certain percentage of carbon and of manganese is present in all the specimens. This is unavoidable in the ordinary process of manufacture; but the authors believe these impurities are present in smaller quantities than in any considerable collection of iron alloys yet made.

A similar effect on conductivity is produced by the different elements when more than one is present in the alloy as was observed when one only was added to iron. In fact, the rate of increase of specific resistance produced by successively adding 1 per cent. of, say, aluminium to iron is almost the same as the rate deduced from similar additions of aluminium to a composite chromium-aluminium-iron alloy, and so with other of these alloys.

The highest electrical resistance of any known metallic wire, commercially useful, has been found in some of these composite iron alloys. Thus an alloy of 25 per cent. of nickel and 5 per cent. of manganese has a specific resistance of 97·5 microhms and a comparatively low temperature coefficient. This alloy is easily drawn into wire, and appears to undergo but little change in heating, and is not an expensive product. It has also some remarkable thermo-electric properties. Many of these nickel-manganese iron alloys were made by Mr. Hadfield many years ago, and their specific resistance and temperature coefficient were determined in 1895. Among these was the alloy containing 15 per cent. of nickel and 5 per cent. of manganese, originally called rheostene, now known as resista, and the physical properties of this material were fully investigated in 1895. Since then various makers have given other names to these alloys and they are to be had on the market. For six years resistance coils made of rheostene have been used in the electric installation and lecture theatre in the Royal College of Science, and no depreciation of the material has been noticed.

The authors have already determined the relative thermal conductivity of upwards of 40 of these alloys, and in every case the electric and thermal conductivities go hand in hand; the causes that diminish the electric conductivity appear to diminish the thermal conductivity.

The preceding results show that the conductivity of iron is in all cases *diminished* by alloying it with another metal, even though that metal be itself a better conductor than iron, except perhaps in the case of an alloy of iron and copper. In the case of the copper-iron alloys the specimens were very few and contained variable amounts of impurity. The only specimens in this group that are at all comparable are two, one of which contains about 1 per cent. more copper than the other, with a little higher conductivity, a difference which may be accounted for by the slightly less carbon and manganese impurities it contains, though both have high carbon. The foregoing results also indicate that reduction of conductivity produced by alloying iron with another metal is not due to the greater specific resistance of the added metal. On the contrary, an iron alloy of *very high* specific resistance is produced by adding to iron an element of *much lower* specific resistance than the iron itself. In fact, the conductivity of the resultant alloy appears to have no connection with the conductivity of the constituents of the alloy. Thus, if we compare an aluminium-iron alloy with a corresponding percentage nickel-iron alloy, the former is a far worse conductor than the latter, albeit pure aluminium is upwards of three times *better* a conductor than pure iron, whereas nickel is a slightly *worse* conductor than iron.

An inspection of figs. 1 and 2 shows that of all the alloys examined the addition of *tungsten* to iron reduces the conductivity the least. The author can find no record of the conductivity of this element having been determined, nor of chromium, manganese, nor silicon, and would be glad if any one could give information on this point.

The effect on the conductivity of iron produced by the presence of small quantities of carbon is strikingly shown in fig. 1. In fact,

other things being equal, the conductivity of a specimen affords a rapid and simple method of estimating the amount of carbon present in a sample of steel, by an inspection of the curve in fig. 1. The rolled and annealed specimens of carbon-iron alloys at disposal did not contain more than 1¼ per cent. of carbon, so that the carbon curves were not carried beyond this point.

Figs. 1 and 2 also demonstrate that the greatest reduction of conductivity, for a given percentage of the added element, is produced by the *first* increments of the element added.

The effect thus produced on the transmission of *electricity* through an alloy of growing richness is therefore analogous to the effect produced on the transmission of white *light* through a medium which is tinted with increasing quantities of colouring matter, the first additions of the colour producing the greatest selective absorption.

In the following table is shown the increase of resistance produced by the addition of 1 per cent. of the element in an iron alloy containing about 4 per cent. of the added element. And in another column is shown the specific heat and the atomic weight of the elements named in the first column.

Iron alloyed with	Specific resistance of 1 per cent.	Specific heat.	Atomic weight.
Tungsten	0·9	0·035	184
Nickel	2·5	·109	59
Chromium	3·0	·1 (?)	52
Manganese	5·2	·122	55
Silicon	10·3	·183	28
Aluminium	11·1	·212	27

It will be seen that the increase in specific resistance follows the same order as the increase in specific heats of the various elements, with the possible exception of chromium, the specific heat of which element is doubtful, and the exact specific resistance produced by that alloy is also a little uncertain. With the same exception, the atomic weight appears to decrease as the resistance of the alloy increases. This, of course, follows from Dulong and Petit's law. If it should prove to be a real physical relationship, it may afford some light on the obscure question of what determines the remarkable increase in resistance when a comparatively good conductor like aluminium is alloyed with iron.

The comparative effect of carbon is extremely difficult to ascertain owing (1) to the impossibility of making alloys of iron with large percentages of carbon, and (2) the difficulty of excluding impurities such as manganese, silicon, &c., from the carbon steels. It is only by comparing the specific resistance of specimens with a similar amount of impurities and different amounts of carbon that an estimate of the effect of carbon can be made. From the purest commercial iron (S C.I.) up to iron containing 0·14 per cent. of carbon, the increase in specific resistance is at the rate of about 2 microhms for *one-tenth of 1 per cent.* of added carbon, but from 0·14 to 1·24 per cent. of carbon the rate of increase in specific resistance produced by the carbon falls to one-fourth of this, viz., *about five microhms for 1 per cent. of added carbon.* The result doubtless depends on the condition in which the carbon exists in the iron with which it is alloyed, and metallurgists have told us there is a considerable difference in this respect. The specific heat of carbon in the form of graphite is 0·16, and in the form of diamond it is 0·113. Hence its place in the above table is between manganese and chromium, and this is also its position as regards the increase of specific resistance it produces in iron for corresponding percentages.

In all cases annealing was found to diminish the specific resistance of these alloys. In one particular composite alloy, containing 14 per cent. of nickel, 5 per cent. of manganese, and 2 per cent. of aluminium, alloyed with 78·5 per cent. of iron, the unannealed alloy had the enormous specific resistance of 89 microhms per c.c., whilst the same specimen annealed was 48 microhms per c.c —a difference of 87 per cent. produced by annealing.

The effect of heat treatment on the alloys of iron containing a large percentage of manganese is, however, different from that produced on most other steels. The slow cooling of a high manganese steel hardens it, whilst rapid cooling softens it. This difference in the effect of heat-treatment probably accounts for the anomalous conductivity shown by certain specimens of manganese steels, as seen in the curves for that alloy in fig. 1. It will be observed that the presence of carbon in any of these alloys greatly diminishes their conductivity, and also their magnetic permeability, as we shall see later on. The difference between the high and low carbon manganese steels is shown in fig. 1.

(To be continued.)

ARMATURE INTERFERENCE AND BRUSH POSITION.

By H. M. HOBART.

A few years ago the sparkless collection of the current from the commutator controlled the rating of continuous-current dynamos, and this gradually improved from the old requirement of sparkless collection with brush position altered for various loads, to the present requirement that the brush position shall remain unaltered for all loads, and, indeed, for momentary overloads of from 50 per cent. to 100 per cent., and for sustained overload of from 25 per cent. to 50 per cent. The rapid introduction of traction and other motors requiring frequent reversal of direction, with brushes in the neutral position, and the demand for shunt motors for running sparklessly at any of a wide range of speeds by field regulation, accelerated the rate of improvement in commutation, and for some time a few designers have ceased to regard the question of sparkless commutation as the limit of output of the dynamo, regarding instead the temperature rise as the limit. Here, also, the improvement has been very marked. The practice of using ventilating ducts and channels, not only through the armature core, but amongst the armature end-connections, through the commutator spider (even of small machines), and often also through the field spool, has completely altered the situation; such ducts and channels have gradually been increased in number, and often in size, and to-day but little difficulty is experienced in working to rigid specifications as regards the ultimate increase of temperature with sustained heavy loads. Even in the case of totally enclosed apparatus, the progress in this direction is rapid, and the patent records now contain descriptions of numerous ingenious and useful constructions devised for the purpose. At present it may be said that the temperature increase has also ceased to be the limit of output, having given place to efficiency and regulation, both of which are often sacrificed to a certain extent in the constructions best adapted to good ventilation and freedom from sparking.

Electrical apparatus has, however, always been characterised by inherently high efficiency. The losses in the generator and transforming apparatus are out of all proportion smaller than those in the prime mover and its auxiliary apparatus and in the transmission system. Whether a 1,000-KW. dynamo's commercial efficiency is 94·5 per cent. or only 94·0 per cent., has practically no influence upon the cost per kilowatt-hour delivered.

Regulation, however, is a much more important factor, and it would hence appear that regulation may at this stage be considered the limit of output.

Regulation is intimately associated with the design of the armature windings, of the field windings, of the magnetic circuit and of the commutator—and very specially with the brush position. The influence of the brush position is very great, yet it is often not recorded in test reports. The tests generally recorded, still rarely comprise more than curves of saturation, core loss, and commercial compounding. This is, indeed, all and much more than can be afforded on the majority of standard machines daily passing through the testing department, but even the outlay for these tests is often wasted. It is no rare occurrence to find unrecorded the speed corresponding to the saturation curve and core loss curve, the *brush position* corresponding to the compounding curve, and the precise conditions of load during the heat run. The temperature measurements at the end of the heat run are rarely taken with sufficient precautions to ensure reliable results. These, however, are complaints of long standing, and perhaps are necessary, since in ordinary commercial testing, the question of expense has to be considered as rigorously as any other part of the total manufacturing cost.

But in determining the lines towards which new constructions should tend, there would be an undeniable commercial value in a few sets of tests on commutating machines, which should include numerous curves based on observations never as yet thoroughly made. It is very difficult to carry out such tests in central stations, for there it is of chief importance to avoid doing anything which could possibly jeopardise the maintenance of an uninterrupted service. As already shown, the difficulties are also great in the manufacturing establishment, since there it is difficult to prevail upon the manufacturer to incur heavier testing expenses than are absolutely required to ensure constructional soundness and compliance with the customer's requirements for the performance of the machine, and it must be admitted that, on large machines, these indispensable tests alone amount to a very appreciable percentage of the factory cost. Tests carried out by institutions for technical instruction have often proved most helpful in supplying such informa-

tion as is required in practice in the interests of the advancement of the knowledge of dynamo construction, and in presenting the following meagre experimental data and the accompanying suggestions for further tests, the writer is prompted partly by the hope that the tests may be repeated with greater care and under better conditions and carried further than is otherwise likely to be the case.

A point of considerable interest relates to the dependence of the regulation upon the brush position. Some tests in this respect were made upon a four-pole 17 KW. 110-volt generator running at 700 revolutions per minute, and the results are plotted in fig. 1. From the curves of fig. 1 the values set forth in Table I. are taken.

TABLE I.

Brush position.	Ampere-turns excitation at following values of load, for maintaining 110 volts.						
	0	¼	½	¾	1	1¼	1½
2½ segments forward ...	2,920	3,180	3,450	3,770	4,150	4,480	4,850
Neutral position	2,900	3,030	3,200	3,430	3,670	3,910	4,130
2 segments backward ...	3,000	3,070	3,160	3,280	3,450	3,650	3,860

From Table I. we find that with 2½ segments forward lead, an increase of 42 per cent. was required in the excitation to maintain constant voltage at full load. With the brushes in the neutral position 26 per cent. was required, and with two segments backward lead, 15 per cent. sufficed, there being, therefore, a great improvement in the inherent regulation with decreased forward lead.

When, however, the compounding is effected by a series winding in the ordinary manner, the regulation is about equally good in all three cases.

This is shown in the following calculation :—

With 2½ segments forward lead ... 4,150—2,920 = 1,230 ampere-turns are required in series coil at full load.

With brushes in neutral position ... 3,670—2,900 = 670 ampere-turns are required in series coil at full load.

With 2 segments backward lead ... 3,450—3,000 = 450 ampere-turns are required in series coil at full load.

As the automatic increase in the excitation effected by the series coil will be directly proportional to the load, the excitation values for the different loads will be those given in Table II., and the corresponding terminal voltages are given in Table III.

TABLE II.

Brush position.	Excitation in ampere-turns.						
	0	¼	½	¾	1	1¼	1½
2½ segments forward ...	2,920	3,228	3,535	3,843	4,150	4,458	4,765
Neutral position	2,900	3,093	3,285	3,477	3,670	3,873	4,055
2 segments backward ...	3,000	3,113	3,226	3,339	3,450	3,563	3,676

TABLE III.

Brush position.	Terminal voltage.						
	0	¼	½	¾	1	1¼	1½
2½ segments forwards ...	110·0	112·0	113·0	112·6	110·0	109·5	108·2
Neutral position	110·0	112·1	113·1	111·6	110·0	109·0	108·0
2 segments backward ...	110·0	111·4	112·3	112·0	110·0	107·8	105·0

The machine had 79 commutator segments, hence 20 per pole-piece, and at full load the armature strength was 2,300 armature ampere-turns per pole-piece.

Although Table III. shows the regulation with a compound winding to be, for this machine, practically independent of the brush position, nevertheless, it is evident that an unnecessarily great lead of the brushes involves additional outlay for field copper and lower efficiency as a consequence of increased losses in the field spools. Machines should, therefore, be designed with very low reactance voltage not only from the standpoint of improving the commutation, but also to secure improved inherent regulation, economy in field copper, and (incidentally and indirectly) improved efficiency.

A very great deal of study has been devoted to the matter of the magnetic commutating zone. The original idea was that this should be relied upon to reverse the current in the coils as they successively came into the position of short-circuit under the brushes. Unfortunately, as the load increases, and with it the need for this commutating magnetic field, the interfering property of the armature magneto-motive force weakens it and distorts it away from the useful position. This is all well known. It has led gradually to the employment of carbon brushes not only on railway motors (where other considerations predominated), but gradually on generators of all voltages in spite of the increased commutator surface thereby required. Lately it has become customary to attribute increased significance to the brush resistance, and ever less and less to the influence of the magnetic commutating field. The writer is strongly in favour of abandoning *all* reliance upon the magnetic field for overcoming the reactance voltage in the short-circuited coil, and to rely merely on so designing the machine that the reactance voltage of the short-circuited coil is so extremely low as to exert no harmful influence whatever. This makes it practicable to set the brushes permanently at the geometrical neutral point, quite out of the way of any commutating magnetic field. This is quite different from the special case

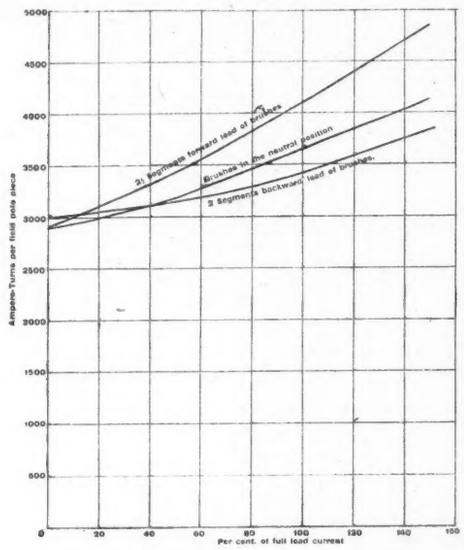

FIG. 1.—CURVES OF EXCITATION REGULATION FOR DIFFERENT BRUSH POSITIONS. TERMINAL VOLTAGE = 110, SPEED = 700 R.P.M.

of railway and other reversible series-wound motors, for in those the speed is less the greater the load, hence, on account of the decrease in the periodicity of commutation as the current increases, the reactance voltage increases by no means as rapidly as the load, and above some particular value of the load the reactance voltage actually decreases, hence the obtaining of reasonable freedom from sparking was—with carbon brushes—fairly effectively achieved in railway motors at a comparatively early date.

This practice of designing dynamos to operate with the brushes set permanently at the geometrical neutral point has the further advantage, already shown in the test above described, of greatly improving the inherent regulation, saving copper and improving the efficiency.

The following table sets forth what the writer regards as a most useful and instructive set of observations to be taken on a commutating dynamo. Even rough determinations of these values afford means for intelligently prescribing the most favourable fixed brush position for a given machine, the decision being controlled by the consideration that, in the interests of regulation, efficiency and economy in spool copper, the brush position should be chosen with as slight a forward lead as is consistent with the commutation requirements.

Experimental Observations on Brush Shifting.

No load.—Number of segments *maximum* brush shift without sparking.

No load.—Percentage *maximum* brush shift without sparking.

Full load.—Number of segments *minimum* brush shift without sparking.

Full load.—Percentage *minimum* brush shift without sparking.

Half load.—Number of segments shift for most sparkless running.

Half load.—Percentage of segments shift for most sparkless running.

Full load.—Segments shift for most sparkless running.

Full load.—Percentage of segments shift for most sparkless running.

50 per cent. overload.—Segments shift for most sparkless running.

50 per cent. overload.—Percentage of segments shift for most sparkless running.

100 per cent. overload.—Segments shift for most sparkless running.

100 per cent. overload.—Percentage of segments shift for most sparkless running.

Best fixed brush position for all loads.—Segments shift.

Best fixed brush position for all loads.—Per cent. shift.

The writer is of the opinion that a machine requiring, for satisfactory commutation from no load to 50 per cent. overload, a forward brush position of much more than 5 per cent. or 6 per cent. of the polar pitch (*i.e.*, much more than 5 per cent. or 6 per cent. of the segments per pole) will in the near future be regarded as hardly a first-class design.

(To be continued.)

TUNBRIDGE WELLS TELEPHONES.

In our last issue we mentioned that application had been made by the Tunbridge Wells Corporation for powers to raise a further sum of £15,000 for telephone purposes, and than an inquiry had been held before an inspector for the Board with regard thereto. Want of space compelled us to withhold a summary of the evidence until this week. For our information we are indebted to the *Kent and Sussex Courier*, in which a full report appeared.

Colonel W. L. Coke was the Local Government Board inspector; Mr. W. D. Cripps, town clerk, appeared for the Corporation; Mr. H. T. Drury opposed on behalf of Col. Holland and other "dissentient" ratepayers; Mr. E. E. Robb appeared on his own behalf as a member of the Council, and various other persons and interests were represented.

Mr. H. C. Cripps, in opening the case in support of the application, gave a sketch of the history of telephonic matters in Tunbridge Wells, culminating in an application for a Post Office license and the starting of an exchange. On October 23rd, 1901, the L.G.B. sanction to the loar of £10,000 was received, in December, 1901, the Telephone Committee recommended the present extension. The original estimate of £10,000 was based on an estimate of 300 subscribers. They had now 533 subscribers connected and 283 waiting to be connected. It was absolutely necessary that the capital invested in the undertaking should be increased, because of the extension of the work and the increase of the subscribers. In the progress of the work it had been necessary to spend more money than was originally estimated. In some places the opposition of private owners had made it necessary to substitute underground cables for the originally contemplated overhead wires, and in other places it had been found desirable to make this alteration, so that natural beauties should not be spoiled. They had actually executed, or were pledged to do so, works to the amount of £19,320. Further extensions were contemplated which would absorb £5,680, thus making £25,000.

The Inspector: How has the money been found over the £10,000 borrowed?

Mr. Cripps: Paid out of the rates. It is an overdraft on capital account. We have not spent it all yet, as there are contracts for a lot of it. Continuing, Mr. Cripps said that as soon as the municipal exchange was opened—in fact, before it was opened—the public had been so delighted with the facilities afforded them by the National that they flew to the municipal. The Corporation system had had applications from subscribers more than they could deal with—the mere fact that 283 people were wishing to go on spoke for itself. They anticipated 300; they had 816. In an undertaking like this they must be continually progressing. They were fighting in keen competition against the National, who were using every possible exertion to defeat the undertaking, and it was only by pushing the thing in an ordinary business way that they would be able to arrive at the result they desired to attain. Petitions had been presented against the further loan, and the petitioners had represented that a loss of £3,000 was being incurred. If this were so, Mr. Cripps admitted that it would be the duty of the Corporation to abandon the enterprise; but, on the contrary, the borough accountant's printed figures showed that with a capital expenditure of £19,320 they had a surplus of £635 after allowing £1,198 for interest and redemption. When the whole of the £25,000 had been expended there would be a surplus of £1,086. When they first started they went in for the toll rates, but they had found it much more convenient to have an instrument at the inclusive rate, and this tended to increase the receipts. Colonel Holland had estimated depreciation at 7½ per cent. He (Mr. Cripps) would now like to know where Colonel Holland got his depreciation at 7½ per cent. from, and why he charged £1,875 under this head. As against this, the Corporation had a modest surplus of £1,086 to fall back upon, but he could not admit that the depreciation on the £3,000 income was to be £1,875. He would like to know how it was that the National Telephone Company were able to pay dividends to debenture, preference, and ordinary shareholders, if out of every £3,000 income they had to set aside £1,875 for depreciation. He challenged Colonel Holland to produce to him a single figure to verify his £1,875 depreciation. He had been misled by these people who had been wandering backwards and forwards between Tunbridge Wells, West Hartlepool, Eastbourne, Portsmouth, and every other place where the Corporation were going to establish a telephone system. If Col. Holland's figures were right, and the undertaking was going to entail £3,000 a year upon the ratepayers, by all means let them pull the poles down and the cables up, and shut up the exchange. But let him apply one more test to prove that the Corporation system would pay. The National Company in Tunbridge Wells was at the present moment just about equal to the Corporation in the number of subscribers. They were getting an average annual receipt from each subscriber of £4 11s. 5d. He challenged the National Company to find a single subscriber to their system paying more than £4. The National were making things pay in Tunbridge Wells at £4 per head. They must be, for they were sound business men, and would not supply telephones at £4 if it did not pay them. They had to face the fact that instead of their license running out in 1925, it ran out in 1910, between which time and the present they had to recoup themselves their 7 millions of capital. What did the opposition suggest? They did not suggest that the application should be thrown out, but postponed. What would be the result? If this loan was refused, the 383 subscribers waiting to go on could not be taken on. No future subscriber could be connected. Instead of the undertaking progressing at the rate he had detailed, and flourishing—for it was only by progressing that it could flourish—it would dwindle and die. The wishes of the National would be justified, but would the wishes of the ratepayers be justified? They must necessarily be charged with the expenditure in the rates. It was a ratepayers' undertaking, and the persons who would lose if the undertaking did not answer would be the ratepayers. The £9,000 which was overdrawn would have to come out of the rates. He would suggest the hour had not arrived when the Local Government Board should cut short this undertaking which had been entered upon in pursuance of an Act of Parliament passed only in the year 1899. They were carrying out the license which had been entrusted to them; they had shown by actual working for six months that they were perfectly justified in their application. They had told the Local Government Board they would have 300 subscribers; they had now 533. They had 287 anxious to go on, and they asked the Local Government Board to give them the necessary capital to carry on their undertaking in a proper and business-like way. He was confident that the Local Government Board would not say to the ratepayers, to Colonel Holland and the other gentlemen who had signed the petition, who also had been grossly misled: "We refuse this loan; you have made a mistake, the expenditure must come upon the rates. We will allow your competitors, who have not come to the Local Government Board for any sanction to their expenditure, to fill up all the ground which, by your license, had been granted to you." When the Local Government Board considered these matters he was certain they would say the application was a reasonable one, and would grant it without any hesitation.

At the conclusion of his long and exhaustive statement Mr. Cripps was cordially applauded. He spoke for over an hour and a half.

Mr. A. R. Bennett, the consulting engineer to the Corporation, then gave evidence, in the course of which he said that the estimated cost was £17 10s.—the actual cost, £21 per line. The amount of underground cable allowed for, in the first place, was 4½ miles; that actually used, 9 miles. He further detailed the extensions contemplated from the new expenditure.

Mr. Cripps: What would result if this loan was not granted?

Mr. Bennett: The ratepayers would lose the whole of the money, if not more than has been expended on the system to date, because the price, the breaking-up price that would be obtained, would not cover the cost of taking down the system, so that, if this opposition succeeds, the present system will have to be entirely sacrificed.

The Inspector: That would be a very good thing for the National?

Mr. Bennett: Exactly.

Mr. Drury, in cross-examination, suggested that Mr. Bennett had spent a good deal of time during the last two or three years in going about the country recommending municipalities to take up telephone schemes, to which Mr. Bennett replied that he always waited for an invitation, and the Inspector intimated that he did not want to hear how the consulting engineer was remunerated.

Mr. Drury: I think Mr. Bennett is remunerated on a percentage. May I take it, Mr. Bennett, if this loan is refused, besides the Corporation of Tunbridge Wells another person will be the loser by it?—If the work is not carried out I should not take any remuneration I should not claim it.

It has been said here that you estimate the cost per line a £17 10s.?—Yes; that was the original estimate.

What do you call your original estimate?—The original estimate dated December, 1899.

The Inspector: The one that accompanied the original application for the loan?—Yes.

Did not you make a report dated November 17th, 1899?—I do not recollect it.

Mr. Drury: Well, Mr. Cripps; have you got it?

Mr. Cripps: I have only the report dated December, 1899.

Mr. Drury: We have asked you to produce it.

Mr. Cripps: You have asked us to produce reports in all cases. You gave us a general notice, which covered every blessed book.

Mr. Drury: I ask you to send someone to find the report dated November 17th—blessed or otherwise.

Mr. Drury: As you go on increasing in numbers, does the total capital cost increase?—Not till the exchange becomes a very large one.

How large?—Several thousands. Fifteen hundred subscribers would not cost more than 300, qualified by local circumstances.

Obviously. Was the scheme which you have put in here a first-class, up-to-date scheme, with all the latest developments?—Yes.

Seventeen pounds is about the same as your estimate for Manchester?—Yes, substantially the same.

May we take it that that was a first-class, up-to-date scheme?—It was.

And therefore, as far as quality is concerned, there is no difference between here and Manchester?—No.

Did that work out when you had finished at something like £35 per line?—No.

Has it been publicly stated that that worked out at £35 per line?—Yes; many times by the National Company.

Was it stated by Mr. Forbes?—Yes.

Mr. Drury: Is Mr. Forbes, to your knowledge, a person competent to deal with figures?—He has made very great mistakes.

Is he an honest person—a reliable, credible man?—I cannot give general testimonials like that.

I am not asking you to give general testimonials: I am asking you to give a testimonial as to the character of a particular man, who, I understand, you have some knowledge of. Is he a credible person or not?—Not very on telephone matters.

Do you ascribe the fact of his saying that £35 was the cost to ignorance or knavery, or both?—I must ask you to define the point. It is not true, I say.

You decline to say whether that is to be ascribed to knavery or ignorance?—If you refer to the reports in the *Times*, giving the account of the Telephone Company meeting at which liquidation was decided upon, you will see that Mr. Forbes, in presenting the accounts, said, "exception may be taken to the way in which these accounts have been made up, but, at all events, this is the way in which we choose to put them."

Will you give the date of that?—Some time in 1892.

You were in possession of that knowledge in 1897?—Yes.

I take it you were present throughout at the municipal inquiry at Glasgow in 1897?—Yes.

Did you suggest to the counsel that he should question Mr. Forbes on those lines?—I did, but he said they were so utterly ridiculous that he would not deal with them, but he dealt with them in an able speech, and very effectively.

With regard to the quality of the plant used in Manchester, how long did the company last. For three years and eight months?—Something like that.

At the end of that time was the plant sold?—Some of it was, and some of it is used to this day.

Substantially it was sold?—No.

Part of it was sold?—Some of it was; I was in Manchester a fortnight ago, and I saw a great part of it still in existence. A portion of the switchboard was sold, I believe.

Did they sell a very considerable portion?—They sold the framework.

They sold the framework for £25?—So they say.

Have you any reason to doubt that that was the price they sold it for?—They said the whole switchboard was sold, but that is not so?

Was it described as a "flimsy and common board"?—No doubt.

Was it examined on behalf of the National Telephone Company by Mr. Sinclair?—I believe it was so stated.

He examined it?—Possibly.

You were not there, then?—No.

An unfortunate juncture of the proceedings to leave. Did he describe it as of a flimsy and common description?—I am not quite sure that he used those words.

Was that in effect the description he gave it?—It was something to that effect.

Is he a person who knows what he is about?—He ought to be.

He has a considerable amount of experience?—Yes.

Was the plant such as would be described as being of a flimsy and common description?—Such a description would be at utter variance with the facts.

The Manchester Plant.

Were some portions of the plant produced at the inquiry "put in," I believe the technical term is?—Yes, and perhaps the Inspector will allow me to make a short explanation.

Permission having been given, Witness said some material was put in, and the principal thing was a cord and plug, which had been used, which was made in 1890, and had been in use in the Mutual Exchange throughout its existence. That was produced, and laid alongside a brand new cord and plug, which had been made in 1897 seven years after; and the Commissioner was invited to notice and judge what a splendid brand new thing the one was, and how shabby and flimsy the other. In telephony, continued Mr. Bennett, we progress very quickly, and a difference of seven years makes a great difference in switchboard designs, and the cord and plug made in 1890 could not be compared with one made in 1897.

Did you take exception to that, asked Mr. Drury, and suggest it as a point to your counsel?—I do not remember taking exception to it.

Anyway, the sheriff who was conducting the inquiry reported that the things were of the cheapest and most flimsy description, and not at all comparable with the plant used by the National Company?—The Sheriff neglected to notice the difference in the dates.

Your explanation of that, I understand to be communicated to the public press, was that the Sheriff was a person who did not know much?—He did not know much about telephony.

And though one of his Majesty's counsel he was a person, in your view, who thought a telephone plant ought to be judged like butcher's-meat?—Yes; he thought anything very small or very light could not possibly be so good.

He must have been a foolish person?—I must leave you to assume that.

Mr. Cripps: I think the result of Glasgow justifies that opinion. The Sheriff's report was not adopted by the Government, so I think there was something in what the learned counsel has just stated.

The witness was further questioned as to the Dundee competitive telephone system, and maintained that it was successful, though the chairman had stated that it was gradually going from bad to worse. Asked as to whether Tunbridge Wells was an easy place to telephone, he replied in the affirmative.

Mr. Drury: Is there anything in the working expenses, as they appear in your original estimate that you desire to correct?—I have allowed for a depreciation fund, which I do not think necessary, but otherwise I do not see there is anything to correct. In regard to some items experience shows that money can be saved.

Would you point out anything?—I estimated the repairs at 2 per cent., but experience shows they do not come to that.

What has been your experience in regard to repairs?—The borough accountant is to follow me, and he has the fullest particulars of all accounts in the books.

What is your experience in Tunbridge Wells?—About 1 per cent.

In six months that would come?—No, 1 per cent. per annum.

You now represent that inspection and repairs come to less than 2 per cent.?—Yes.

Cost of Repairs.

You seriously represent that 2 per cent. is a proper amount to charge as to ordinary inspections and repairs?—Yes, it is a liberal allowance indeed.

The Inspector: What does that include?—Inspection and repairs to instruments, to see that the battery is up to the mark, and removing any faults.

Mr. Drury: You say that applies to this £25,000 expenditure?—It would not be so much on the £25,000, because by dealing with the quantity it can be managed cheaper.

You seriously say that on the capital expenditure repairs and inspection would not come to 2 per cent?—That is my statement, and I can support that. There is a municipal system in—

Guernsey?—Yes.

I thought so. You can get to the repairs by putting Guernsey figures, and you will find they do not work out at anything like 2 per cent. on the capital expenditure.

In order to attach any value to that, one wants to get at the capital expenditure, and how it was arrived at. What do you pay for poles in Guernsey?—They would cost more than here, because of the carriage.

What do they cost?—I do not remember.

I suggest they did not cost anything at all?—You would suggest something very far away from the truth, because they cost more than in Tunbridge Wells, owing to the freight.

Did not you have the poles given you?—No, by no means. We bought our poles at North Shields, and they were delivered in Guernsey, some by sailing ship and some by steamer, which we paid for in hard cash. British currency and the rate all round was dearer than the rate at Tunbridge Wells.

Do you say that nothing is necessary for a renewal fund?—The opinion on that is very much divided. I am of the opinion that nothing is necessary.

You have told us, I think, that progress is the soul of this telephony?—I did not put it that way; I said telephony progressed.

Very much of the same thing?—It is not the soul, though.

It was absolutely unfair that things constructed in 1890 should be compared with things made seven years later. Is it a fact that this is a science which is progressing from day to day?—Yes, I hope it is.

Fresh plant and inventions are coming out, and it frequently happens that in five years the plant is taken out, and other put in?—No, the National Company are using plant which have been in use for 18 and 20 years.

I think you told them at Glasgow that they had taken out and renewed the whole of their plant?—I don't recollect stating that in Glasgow——

I suggest you did?—I have no recollection.

That did not appear to you to be an extraordinary thing?—It would be an extraordinary thing.

It is quite possible in the course of 25 years that extraordinary developments may take place, and the plant will have to be replaced?—We cannot gauge possibilities.

Then you agree with me that it is quite possible, in the course of 25 years, it may necessitate the taking out the whole of this plant, and putting in fresh?—No; the depreciation would be restricted to certain parts of it. The other parts, insulators and poles, would last for a very much longer time than 25 years.

Yes, but I am not talking of the wear and tear. I am talking of development?—There are such large profits on a telephone under-

taking, that the plant which was put down would make a depreciation fund absolutely unnecessary.

Assume for a moment the possibility of there being no profits?—I cannot assume such a ridiculous proposal, because no telephone exchange, large or small, has been known to involve its owners in a loss.

Suppose it did not answer, and made no profits?—But I know we shall.

Assume you did not?—Well, I shall assume something that has never happened.

(To be continued.)

CORRESPONDENCE.

Electrical Power Schemes: A Comparison of Two Recent Papers.

Until the publication of Mr. Andrew Stewart's paper on "Sub-Station Equipment and Transmission Line," read before the Newcastle Section of the Institution of Electrical Engineers on January 27th, 1902, and that by Mr. Hardman A. Earle before the Manchester Section of the Institution on the following day, there was little or no information to be had regarding electrical power distribution under British conditions; and it is a remarkable coincidence that two papers on the same subject and so closely resembling each other should be read on two consecutive days, though it is a subject which is engaging the attention of most electrical engineers.

From the titles of the papers one would expect to find a fair amount of discrepancy, but since the same questions arise in both papers, it is remarkable to find how nearly the two authors coincide in their estimates, which of necessity must be somewhat hypothetical.

Whereas Mr. Earle is of opinion that we in this country can found our large power schemes on similar lines to those abroad, Mr. Stewart holds the opinion that new problems must be met and *overcome*.

With the exception of the Newcastle Supply Company, of Wallsend, there is not a large power scheme in this country which can be called a working success, and the latter has only just started running on load.

Both authors are agreed, and the electrical engineering profession supports the view, that *overhead bare* conductors at high voltages of 10,000 or 15,000 must be allowed by the B. of T. before these schemes can become a financial success, and after all electrical engineers are judged by the *financial* success or not of their schemes.

From Mr. Earle's curves I deduce that he considers a maximum economical limit of voltage is reached at 4,000 volts for 200 KW., rising up to 10,000 volts for 2,000 KW., and Mr. Stewart proposes an economical limit of 7,000 volts for 300 KW., 10,000 volts for 600 KW., and 15,000 volts for 1,000 KW.

Here there is considerable difference of opinion, due, no doubt, to the curves being plotted from the capital cost of cables, as to which the authors do not agree, and it would be interesting to know from what sources these figures emanate.

The permissible waste of energy in the cable seems to have been nearly the same in both cases, and both authors agree that Kelvin's law for equating interest and depreciation losses to energy losses in watts will not hold good for dear cables and cheap power.

Mr. Earle seems to prefer constant current density, while, from Mr. Stewart's curves, figs. 3 and 4, it would appear that he has taken a variable density, starting with 884 amperes per sq. in. at 7,000 volts, and reaching 1,400 amperes per sq. in. at 15,000 volts.

For 1,000 KW. Mr. Earle gives a "*cheapest voltage*"—

At 6,000 with 1,000 amps. per □″ and loss in watts of 1·25 per cent. per mile.

At 8,000 with 1,000 amps. per □″ and loss in watts of 1 per cent. per mile.

Mr. Stewart's "*economical voltage*" for a similar power with a power factor of unity and 1 per cent. loss in watts per mile is 15,000 volts—about double.

As to *periodicity*, 25 is recognised by both as being most suitable for rotatory or rotary converters, and 40—50 for motor-generators and arc lighting work.

An assumed load factor must be a very unstable and unreliable quantity, and even after several years' working, a scheme may not reach so high a figure as Mr. Stewart gives, *i.e.*, 35; Mr. Earle's being more reasonable—25.

For generating station costs both authors come somewhere near the mark, Mr. Stewart's £25 per KW. installed corresponding with Mr. Earle's £21·1 per KW. installed, taking into consideration the relative sizes of schemes, *i.e.*, 16,000 I.H.P. for the former, and 25,000 I.H.P. for each station of the latter. One would expect the cost per KW. to decrease as the size of station increased, probably in a parabola.

Compare the prices per mile at various voltages of the trunk mains, of capacity 1,000 KW. and 1 per cent. loss per mile, Mr. Stewart taking *two cables*, and Mr. Earle *only one*:—

At	7,000 volts	£900	(Stewart)	against	£650 (Earle).
,,	8,000 ,,	870	,,	,,	630 (*lowest*).
,,	10,000 ,,	760	,,	,,	670.
,,	11,000 ,,	740	,,	,,	700.
,,	15,000 ,,	720	,,	,,	Increasing.

The costs of laying the cable and re-instatement, taken by Mr. Stewart at £587 (for two cables), and £422 by Mr. Earle (for one) per mile, are about right, and fairly proportionate, as the labour in laying two cables is approximately one-third as much again as laying one.

Rotary converters and motor-generators, as purchased by the authors, afford an excellent opportunity for making or losing money, Mr. Stewart's figures running much higher than Mr. Earle's.

Rotary converters	£4·75 per KW.	(Stewart)	£4	(Earle).
Motor-generators	5·5 ,,	,,	4·5	,,

It is of the greatest importance in comparing these figures to notice the facts as to whether KW. *installed* or KW. *maximum demand* is given, as the latter increases the cost per KW., and the *diversity factor* decreases it.

Mr. Earle does not take this into consideration, probably because his figures are already somewhat low, as, for instance, £500 for buildings of sub-station as against £900 by Mr. Stewart for a plant 35 per cent. smaller.

Allowing £500 for the switchboard as in Mr. Earle's estimate, the total cost per sub-station per KW. *installed*, run outs:—

£4·6 (Earle)	£6·9 (Stewart)
or £9,200 total.	or £8,650 total.

The comparison in capital expenditure per KW. installed is as follows:—

	Earle.	Stewart.
Generating station ...	£21·1	£25
Trunk mains (one cable) ...	5·6	15·7 (two cables)
Distributing mains ...	5·6	not dealt with
Service mains	3·25	not dealt with
Boxes	·16	—
Buildings—sub-station ...	·25	·72
Machinery	3·65	4·75
Switchboard	·25	·25
Total ...	£39·86	£46·42

In conclusion, I must congratulate both authors for the excellence of their papers, and also for their fortitude in coming to the front on a matter of such universal and vital importance.

P. M. Bennett.

Protection.

From a purely selfish author's point of view I am grateful to you for the review you have bestowed upon my book "Protection;" both the space you have allotted for this purpose, and your remarks, are such as may induce many of your readers to buy and read my book, and to judge for themselves whether the criticism which you have made is deserved or not. But there may be some (I hope there are but few) who may not have taken the trouble to read my book, and who may have judged me solely from your remarks. Will you, therefore, kindly allow me space to reply to some of your criticisms:—

In your review you refer to one main argument only, but you have much to say on the side issues. It is true that that argument is a most important one, and with your permission I will repeat it:—

"A manufacturer in a protected country can manufacture at a cheaper rate than a manufacturer in a free trade country, because the cost of production is reduced in proportion to the quantity manufactured, and the producer who has two markets open to him can make larger quantities than the one who has only one market."

You agree to this, but qualify your agreement by saying that this principle is unquestionably sound up to a point (*a*). I ask you, Why up to a point, and where does this point begin? It is my contention that there is no such qualifying point, and that the principle which I put forward is true on every article manufactured, be it one that is made by the thousand or one made by the dozen; be it one valued at a penny or one valued at thousands of pounds. In connection with your remarks you draw in internal competition, demand, patents and combines, but I fail to see what these matters have to do with my proposition.

My proposition is simple and clear, and I believe any manufacturer will support me by saying that it is true. If it is true, then I say that free trade is such a disadvantage to us, that no advantage you may be able to argue in its favour could possibly outweigh it: because, if we cannot manufacture in this country as cheaply as other countries can manufacture, then it will only be a question of time when we shall lose our industries which leave us a profit, and consequently our national wealth.

You, like other free traders, have really only one argument to urge in favour of free trade, *i.e.*, *cheapness to the consumer*. It is my opinion that this cheapness in reality does not exist, but whether it does or does not, it really has nothing to do with the preservation of our national wealth. A man does not get wealth by living at a cheap rate, but by the result of his labour. So much for the main argument you touch upon.

You bestow a great deal of sarcasm upon my recital of the history of the telephone industry in England, and I may say that it rather surprises me. I thought I should have had your full concurrence and sympathy with the remarks I make and the moral I deduce therefrom. I have brought forward the present state of the telephone industry in our country as one of the several examples to prove that the existence of our patent laws, combined with our free trade policy, absolutely prevent any new industry from starting and flourishing in this country. I challenged my readers to prove the contrary, but you have not taken up that challenge—contenting yourself with trying to ridicule some sentences arbitrarily selected by you. Then I referred to the fact that many pioneer manufacturers were prosecuted, and some imprisoned. You say in effect: Serves them right because they infringed the country's laws. But what I complain of is, that such laws exist, laws which enable a single man to kill a great industry in its inception, and I ask you whether you yourself approve of them (*b*).

Again, I referred in my book to my repeated applications to Mr. Morgan for a license to manufacture and sell telephones. You accuse me on this and other points of exaggeration or making mis-statements, but I would respectfully point out that it is you who are misinformed. You say that the United Telephone Company had disposed of their manufacturing rights to the Consolidated Company (*c*). Anyone who knows the history of the telephone can inform you that the Consolidated Company possessed no exclusive license, and that their license was confined to manufacturing and selling for abroad only; they had no right to dispose of a single telephone in this country, except, of course, to the parent company, who hardly bought anything from them, but supplied their own wants almost entirely from abroad. How you can, in the face of these facts, assert that the telephone patents were "exploited by manufacture" in this country I am at a loss to understand (*d*).

Your defence of the present patent law by saying that it protects trades (*e*) without restriction is an altruism which cannot be put into practice in everyday commercial life. I must confess that in matters of trade I prefer to pursue a selfish policy, as I have found from experience that neither thanks nor profit is to be got out of giving away things for nothing.

You also accuse me of being "very irate with the Government for strengthening the monopoly which the Americans hold in telephones." I should like to ask you whether you are particularly pleased with the action of the Government in this matter, and whether it affords you pleasure as a British commercial journal to know that the Government's new central telephone exchange is almost entirely fitted with instruments manufactured in other countries (*f*).

My book has been written with a view to reopen the question of our fiscal policy, because times have materially changed since it was adopted. I do not complain that, although the opinions, arguments and facts which I have used are to my mind incontrovertible, you have selected only a few of them with a view of refuting me; but I hardly think you have made out a good case on your side (*g*). Still, I wish to express my obligation to you for having so far assisted me as to bring some of my arguments before your readers, and thereby to cause many of them to think over an important subject.

May I conclude by saying that I have, through the publication of my book, obtained some indication as to the feeling of the country upon this great question of protection; and that I find that the feeling in favour of it is much more pronounced than many people think, and I am confident that it will be in the forefront of politics at no distant date.

G. Byng.

71, Queen Victoria Street.
February, 1902.

[In our review we stated that it would be useless for any ardent free trader to argue with Mr. Byng. We do not propose to attempt a hopeless task, and therefore limit our observations to the following questions, mainly of fact:—

(*a*) The completion of the sentence in our review helps to the understanding of the point.

(*b*) To comply with the law is the duty of every citizen. To seek to amend an unjust law is also the duty of every citizen. The amendment is dependent upon getting a sufficient number to agree as to the injustice.

(*c*) An entirely accurate statement on our part.

(*d*) Our review related to Mr. Byng's book. Mr. Byng restricted himself in his book to the word "manufacture." Manufacture and general sale are far wider questions.

(*e*) We said "protects *brains* without restriction."

(*f*) We take it to be the first duty of the Government to make a success of their undertaking. We may share Mr. Byng's vain regrets, but we cannot recognise that the circumstances as they exist are attributable to the causes to which he assigns them.

(*g*) We did not expect for one moment that Mr. Byng would think so.—Eds. Elec. Rev.]

Worksop Electricity Works.

In your notice of these in your issue of February 21st, you describe and illustrate the air pumps of the condensing plant as Hall's, whereas the idea of the combination and the design is mine, and they were not only installed by, but also made by, Messrs. Jas. Carter & Sons, Stalybridge, Messrs. Hall supplying the steam cylinders only.

Again, the economiser is one of Jas. Carter & Sons', made by them under the Pimbley patents, of which they are the proprietors, and of an entirely different type to Green's pattern.

As Messrs. Carter & Sons have in hand similar plants for other electric light works, and anticipate a large demand owing to their very economical working at all loads, the matter is of considerable importance to them, and I trust you will give this correction equal publicity to your notice.

J. E. Weyman, M.I.Mech.E.

Manchester, *February 22nd*, 1902.

Economy of Isolated Plants.

I have read with interest Mr. Dumaresq's letter on the question of isolated electric plants, as it suggests that the figures given agree with those of the American plant quoted in your article, and the results therein mentioned might lead others who, like myself, are not central station engineers, to alter their opinion that isolated plants are seldom advisable if a satisfactory supply can otherwise be obtained. I cannot,

however, discover that Mr. Dumaresq's figures are in accordance with those cited by Mr. Parsons, nor do they really warrant the deduction he draws from them as to the economy arising in this instance from an isolated plant as compared with public supply upon the terms prevailing in the district in which the plant in question is situated. Mr. Dumaresq does not state in his letter the amount of capital employed in the installation he refers to; I find, however, in the "Central Station Directory for 1901—2," a return in which the capital is given at £6,000, and it there states that the present plant has replaced a gas-driven one.

The first question I should like Mr. Dumaresq to answer is:—Was the old plant written off by yearly depreciation, or was there finally a loss on capital account which had to be met? The "General Repairs" account bears apparently no relation to the capital employed; I, therefore, ask whether this account includes all items necessary to maintain the plant at its initial efficiency?

"Wages chargeable to generating costs": in the Directory I find it stated that five assistants are employed, it is also mentioned that 52 arc lamps are in use, and of course Mr. Dumaresq is entitled to take credit for all labour in repairing and trimming these, but the 14-hour runs in the winter months must call for two shifts in the engine room or extra expense on overtime, and the five assistants, assuming these to represent the engine room staff, can hardly be considered as overpaid on the amount, £376, charged as wages. Under these conditions the chief engineer apparently does not figure in the costs quoted; will Mr. Dumaresq kindly explain?

"Depreciation" is set down at £344—I have already referred to the capital outlay of £6,000—will he kindly state how the depreciation item is arrived at, assuming that these figures are to "agree in a remarkable manner with those of the American plant," where 5 per cent. (in this case £300) is reckoned as interest on the capital outlay, 5 per cent. as depreciation on machinery, and 8 per cent. on boilers and connections?

"Rental value." This is, of course, an estimate, but buildings of the requisite size within a stone's throw of the busiest centre of Kensington can only be described as extremely cheap at an inclusive cost for rent, rates and taxes of £115.

These questions arise from the works costs cited, but there are further costs incidental to the supply under these conditions for which I find no allowance made.

Are we to understand that no insurance of buildings or plant for fire, boiler insurance, employers' liability and third-party risks, breakdown of plant, &c., is made, or if made, why does it not appear as a cost?

I see no allowance for office expenses, stationery, and the like, and it is to be assumed that an isolated plant of this size cannot be run without expense incurred on these items.

Finally, I would ask whether the Supply Company's charge as published, and allowing the rebates applicable to this class of lighting, would not in this instance be 3d. per unit and not 5d.? whether, therefore, it is not a fact, under these conditions and with the requisite modifications in his analysis of costs to really represent the facts, that Mr. Dumaresq's total cost must exceed that at which a public and *continuous* supply can be obtained?

H. Moul.

Accumulators and Electric Traction Systems.

With reference to the interesting curves demonstrating the advantage of a booster-worked battery in a traction station, which Mr. Moore gave in his letter appearing in your issue of December 20th last, it would be of value to have some further particulars of the plant operated.

Would it be too much to ask Mr. Moore to inform your readers of the number of cars operated, character of the road, type and connections of the booster used, variation of the bus bar voltage, and if the generator was level or up-compounded?

H. W. W. Dix.

ADDRESS.—Will Mr. H. Watts kindly let us know his address?—EDS.

LONDON COUNTY COUNCIL.

THE Council, at the meeting on Tuesday, resolved to lend £20,000 to the Poplar Borough Council for engineering works in connection with the generating station, £18,000 to the Shoreditch Council for similar purposes, £3,000 to the Stoke Newington Council for mains and meters, and £7,480 to the Hampstead Council for electric lighting works.

Mr. G. H. RADFORD, chairman of the Parliamentary Committee, proposed that the Council should oppose the North Metropolitan Electric Power Supply Bill, and seal and present a petition, and that the costs and expenses should be charged to the county fund.

Mr. M. BEACHCROFT remarked that the area was entirely outside the County of London, and he failed to see why the County Council should oppose the company, whose object was to supply Willesden. The Council should encourage private enterprise where it was unable to do the work itself, and he therefore moved, as an amendment, that the opposition should be limited to securing amendments to protect the interests of the Council.

Mr. STUART SANKEY seconded the amendment, on the ground of the large expenditure incurred by the Council in promoting and opposing Bills. He considered the Bill under discussion to be a good one.

The CHAIRMAN of the Parliamentary Committee said it was somewhat inconvenient for the merits of the question to be raised on that occasion. They ought to have been considered three weeks previously when the Council resolved to petition against the Bill. It was now only intended to comply with the provisions of the Borough Funds Acts, which enabled the Council to charge the expenses upon the county fund. The mover of the amendment had stated that the undertaking was outside the county, but he had omitted to inform the Council that the company proposed to take powers to supply electricity within the county, and in order that the Council might make proper terms the Committee asked for power to oppose the Bill.

The amendment was defeated on a show of hands, and on a division the recommendation was carried by 86 votes to 18.

The General Purposes Committee submitted recommendations in regard to the future course of procedure in connection with electric tramways and the removal of the electrical engineer from the engineer's department in order to be placed under the tramway manager. These recommendations, the substance of which was given in the last issue of this journal, were adopted without discussion.

The adjourned report respecting the tenders received for the supply of rails for the extension of the electric tramways was brought forward, but was again postponed until next week.

The Parliamentary Committee reported that the Bill promoted by the London United Tramways Company proposed to authorise the construction of about 23 miles of new tramways, of which nearly eight miles would be situated within the County of London, and in Hammersmith, Kensington, Paddington, and Westminster. A tabulated list of the projected lines was submitted by the Committee, who recommended the Council to refuse its consent required by the Standing Orders of Parliament to the construction of such of the lines as would be within the county. The consideration of the recommendation was adjourned.

LEGAL.

CHARLES BRIGHT'S AFFAIRS.

ON Friday, in the Chancery Division, Mr. Justice Byrne had before him the cases of Moreno *v.* Wharton, and Bright's Light and Power Company, Limited *v.* Moreno. Mr. Levett, K.C., said he believed his Lordship had made a winding-up order in the case of Charles Bright & Co., Ltd., which he thought was a bar to the action unless they obtained leave to go on. It did not hurt his (Mr. Levett's) friends; and it was clear that until they had proper leave they could not go on.—Mr W. Coldridge said he did not see any ground for a stay. This was Bright's Light and Power Company, Limited, and the question was as to who were the directors.—His Lordship: Whose motion is this?—Mr. Levett: My motion, my lord.—Mr. Coldridge: It is to discharge my receiver.—Mr. Rowden, K.C., said there were consolidated actions, and one company being wound up there was no need for service there.—Ultimately, on its being pointed out that it was a defective action, counsel undertook to amend their application as against Charles Bright and Co., Ltd.

NEWMAN *v.* THE MAYOR AND CORPORATION OF SOUTHAMPTON.

IN the Court of Appeal on Saturday Lords Justices Romer and Mathew heard an application on behalf of the Corporation for a stay of execution, in an action brought against them by one of their workmen who was injured while employed in the electrical tramway yard. The County Court judge awarded the plaintiff £36 and 12s. per week during incapacity to work, and it was in respect of this award that the Corporation desired a stay. It was stated that the case involved a very important question as to whether the electric tramway works were a "factory within the meaning of the Act," and that the matter would probably go to the House of Lords. Their Lordships granted a stay in regard to the £36, but not in regard to the weekly payment.

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HIRAM MAXIM ELECTRICAL COMPANIES.

THE action of the Hiram Maxim Electrical Lamp Co., Ltd., *v.* Sir Hiram Maxim's Electrical Engineering Company, Limited, was mentioned before Mr. Justice Swinfen Eady in the Chancery Division on 21st inst.

Mr. EVE, K.C., said in this case he had a motion to stay further proceedings in the action on the ground that there was a submission to arbitration in the agreement between the parties.

Mr. MACNAGHTEN, K.C., said an important matter was that there was still another motion in which his learned friend was for the plaintiff, in which he sued, as shareholder of the company, to restrain the plaintiff company from enforcing certain calls.

The motions were adjourned for a week.

LONDON ELECTRIC SUPPLY CORPORATION *v.* BRICKWELL.

MR. JUSTICE CHANNELL, sitting in the King's Bench Division, without a jury, on Saturday, heard this case, which was a claim to recover £68 4s. from defendant, the lessee of the Court Theatre, Sloane Square, for electric light supply. It appeared that the parties arranged at the beginning of last year that if the theatre was sub-let the plaintiffs were to arrange with the sub-tenant. This had happened, and notice was duly given, but eventually a company was formed, the defendant being appointed manager, to acquire the theatre, and by an oversight notice of the change was not given to the plaintiffs, though the defendant said in his evidence that he had informally told them that a company would be formed and that accounts should be sent to the company.

His LORDSHIP found that defendant had never accepted the liability of the company in place of that of the defendant, and gave judgment for the plaintiffs for the amount claimed, with costs.

PARLIAMENTARY.

STANDING ORDER PROOFS.

THE Standing Orders Committee has reported that the Charing Cross, Euston and Hampstead Railway (No. 2) Bill may be proceeded with provided that the powers to construct railways Nos. 2, 3 and 4, be struck out of the Bill. The railways thus struck out are a line 1 mile odd in length proposed from Highgate to Hornsey; a line 5 furlongs and 4 chains from Charing Cross to Parliament Square; and the line from Parliament Square to Victoria Station.

The Standing Orders Committee has reported that in the case of the Saddleworth, Springhead and Lees Tramways Bills with respect to which standing orders had been found not to have been complied with, the promoters shall be allowed to proceed.

On Friday it was found that the Standing Orders of the House of Lords had been complied with in the case of the Northumberland Electric Tramway Bill and the Tyneside Tramroads and Tramways Bill.

The Wrexham District Tramways Bill came before the House of Lords' Examiner on Monday, and Standing Orders were found to have been complied with.

The following Bills came before Mr. Campion on Monday for proof of compliance with the Standing Orders of the House of Commons:—

Rossendale Valley Tramways.—Standing Orders were found to have been complied with in respect to this Bill, which authorises the Rossendale Valley Tramway Company to construct some six miles of new tramways as extensions of their present system.

Exeter and District Tramways.—It was found that Standing Orders had not been complied with in the case of this Bill, which seeks to incorporate a tramway company which will lay down a service of tramways in Exeter and the district. The Bill will now have to go before the Standing Orders Committee, who will decide whether or not it shall be allowed to proceed.

North Ormesby, South Bank and Grangetown Tramways.—There was no appearance in connection with this Bill, and it was marked "dead." The power sought was to incorporate a company with a capital of £54,000 to construct electric tramways in the district named.

It was decided to postpone the consideration of the following Bills till March 3rd:—Newcastle-on-Tyne Corporation Tramways, Torquay and Paignton Tramways, London County Council Tramways and improvements, Croydon and District Electric Tramways, London United Tramways and the Birmingham and Midland Tramways.

PETITIONS AGAINST PRIVATE BILLS.

AMONGST the recent petitions which have been lodged against private electrical Bills are the following:—Hanley and Burslem Corporations and the Urban District Councils of Fenton, Turnstall and Wolstanton against the North Staffordshire Tramways Bill; the London County Council against the City and Brixton Railway Bill; the promoters of the Piccadilly and City Railway against the London County Council Tramways Bill.

The Great Eastern Railway have withdrawn their petition against the Norwich Corporation (electricity, &c.) Bill, and the London and North Western Railway Company have withdrawn their petitions against the North Metropolitan Tramway Bill.

ERDINGTON TRAMWAYS.

THE Erdington Tramway Bill came before a Select Committee of the House of Commons, presided over by Mr. Ashton, on Tuesday. The object of the Bill is to enable the Erdington Urban District Council to construct tramways in the district, at a cost of some £100,000. It was announced that the only opposition—that of the London and North-Western Railway—had been withdrawn, and accordingly the Bill was referred back to the Chairman of Ways and Means as an uncontested measure.

METROPOLITAN DISTRICT RAILWAY BILL.

THIS Bill was found to have complied with the Standing Orders of the House of Commons on Tuesday. Particulars of the Bill have already been given in the ELECTRICAL REVIEW.

LONDON & BRIGHTON ELECTRIC RAILWAY.

AFTER an inquiry lasting over a week, Mr. Campion, the Examiner of the House of Commons, has found that Standing Orders have not been complied with in the case of the London & Brighton Electric Railway Bill. The matter will now go before the Standing Orders Committee of the House, who will decide whether Standing Orders shall be suspended to allow of the further progress of the Bill.

Tyneside Tramways and Tramroads Bill.—The Standing Orders Committee have reported that Standing Orders may be dispensed with in the case of the Tyneside Tramways and Tramroads Bill, and the Bill allowed to proceed provided that Tramway No. 4 and Tramroad No. 9 be struck out of the Bill. Tramway No. 4 was a proposed line, 2 miles 3 furlongs odd in length, in the parish of Longbenton, and Tramroad No. 9 a section 1 mile 4 furlongs in length in the same parish.

Garston and District Electric Supply (Transfer) Bill.—This Bill came before Mr. Campion for proof of compliance with Standing Orders on Tuesday, and the necessary formalities were found to have been complied with.

London United Electric Railways.—The Standing Orders Committee of the House of Lords have dispensed with Standing Orders to allow of Earl Cadogan presenting a petition against the Bill.

City and North-East Suburban Electric Railway (No. 2) Bill.—The Standing Orders Committee of the House of Lords have suspended Standing Order 92, and given leave to the Borough Council of Bethnal Green to present a petition against the Bill.

BUSINESS NOTES.

Electrical Wares Exported.

WEEK ENDING FEB. 26TH, 1901.		WEEK ENDING FEB. 25TH, 1902.	
Alexandria	Value £30	Adelaide	Value £180
Bangkok	29	Alexandria	43
Barcelona. Teleg. mat. ..	83	Bangkok	30
Bombay	420	Brisbane. Teleph. cable ..	528
Braila. Teleg. cable	190	Calcutta	1,679
Calcutta	320	Canada (*via* the States). Teleg. mat.	16
,, Elec. machinery ..	3,387	Cape Town	477
Cape Town	151	Colombo	268
Coatzacoalcos. Teleg. mat. ..	75	Constantinople. Teleg. mat. ..	35
Colombo	22	Copenhagen. Teleg. wire ..	153
Durban	548	Durban	206
East London	15	East London	424
Fremantle	198	Greymouth	178
Gibraltar	40	Hong Kong	265
Grenada. Teleg. mat.	75	Lyttleton	550
Hamburg	93	Malta. Teleg. cable	12,960
,, Teleg. mat.	300	Melbourne	150
Hong Kong	108	New York	60
Lyttleton	203	Perth	150
Madras	17	Shanghai	81
Malta	30	Stockholm. Teleg. cable ..	65
Melbourne	552	Sydney	57
Ostend	75	Wellington. Teleg. wire ..	584
Port Chalmers	58	,, Telephones ..	925
Rotterdam	19		
Shanghai. Teleg. cable. .	48,000		
Singapore	419		
,, Teleg. cable ..	11,000		
Suez. Teleph. cable ..	12,500		
Sydney	1,058		
,, Teleg. mat.	680		
Wellington	70		
Total ..	£80,765	Total ..	£20,153

Foreign Goods Transhipped.

Barbadoes. Tph. apprs.	Value £40	Barbadoes. Teleg. mat.	Value £65
		Calcutta. Elec. light fittings ..	81
		New York. Elec. mat.	80
		Trinidad. Teleph. mat. ..	44
Total	£40	Total	£270

Acetylene Lighting.—Mr. John C. Christie, of Aldgate, is at present fitting up the new Board School at Fulham Palace Road with acetylene. The generators and purifiers used are of the Thorn & Hoddle Acetylene Company, Limited, of Westminster, manufacture.

Action.—At the Godalming County Court last week Arthur Hearne, electrical engineer, of Stanley Road, Woking, claimed £44 6s. and £5 damages from W. W. Gale, a local builder,

who engaged him to fit up a number of houses at 8s. per point for bells, and 12s. 6d. per point for lights, paying out £2 weekly, and the balance on completion. Defendant had failed to keep up his payments, and plaintiff was awarded a verdict for £44 6s., with costs.

Bankruptcy Proceedings.—March 8th is the last day for receiving proofs for intended dividend in the case of C. A. Church (H. Conolly & Co.), manufacturing electrical engineer, of Hampstead, Kentish Town, and Ilford. Mr. L. H. Lemon, of King Street, E.C., is trustee.

Liquidation.—A meeting of Mossberg Roller Bearings, Limited, will be held at 32, Victoria Street, S.W., on March 21st, to hear an account of the winding-up from Mr. P. H. Carter, the liquidator.

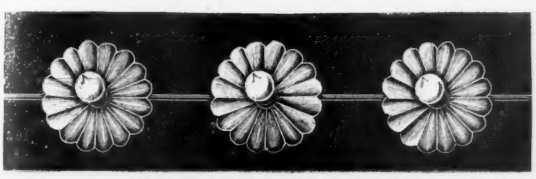
Books Received. — "Science Abstracts," No. 50, February 25th. London: E. & F. N. Spon, Limited. 2s.

"Hydraulic Motors and Turbines," by G. R. Bodmer. London: Whittaker & Co., 1902. 15s.

"Class List and Index of the Periodical Publications in the Patent Office Library." London: Patent Office, 1902. 6d.

"Directory of Statistics of Electric Lighting and Traction Works," 1902. Edited by C. S. Vesey Brown. London: Hazell, Watson & Viney, Limited. 6s net.

Coronation Illumination. — The Imperial Electric Lighting Company (13, Gate Street, Holborn), are devoting special attention just now to the problem of decorative lighting at a minimum cost. Simply, their system consists of ordinary twin cable to which ordinary lamps are attached by a special socket. The adaptability of the arrangement, and the fact that it can be fitted up and altered without skilled assistance, meet the wants of those who study variety of effect and economy of cost. But for illumination and



decorative purposes coloured lamps are used, and each is provided with a stamped metal shade enamelled in some art colour, which gives to the light a bright floral appearance which is very striking. Provided with these shades, the strings of lamps can be formed into any desired devices, such as stars, crowns or initials. The whole of the combination is thoroughly water and weather proof, and therefore very durable for outside purposes. Our illustrations give a good idea of the appearance of this system of lighting with and without the floral shades.

Catalogues and Lists.—A new pamphlet has been issued by the Edwards Air Pump Syndicate, Limited, in which they describe and illustrate their air pumps for condensing plants at electrical and other land installations. A list is given of the principal electrical stations in which the Edwards pump is doing service.

Messrs. C. J. Thursfield & Co., of Cecil Street, Birmingham, have recently issued a new catalogue of electric light fittings, in which they show a number of excellent illustrations of some pleasing early English designs of pendants, electroliers, *repoussé* brackets, &c. The fittings shown therein can be seen at their showrooms in London, at Colonial Buildings, 50, Hatton Garden.

From Messrs. Graham, Morton & Co., Limited, we have received a pamphlet describing their latest system of automatically discharging ash from boilers. It consists of a patent automatic ash discharger, so arranged as to automatically discharge the ash from the boilers, which hitherto has been done by manual labour. By this system, which is fully explained in the pamphlet, the coal and ash in connection with the boiler house is not handled throughout its whole process by manual labour. The system illustrates an improved connecting link between the handling of coal and ash in boiler houses which is claimed at the present time to be the only automatic means in existence. The pamphlet also describes a complete boiler house on this system which Messrs. Graham, Morton and Co., Limited, have erected at the Kensington and Notting Hill electric light works to the designs of Mr. H. W. Miller, chief engineer.

Messrs. Edwards & Marsden, of Birmingham, have just issued for the use of architects, electrical engineers, and the trade generally, a new catalogue in which they show a few of their designs of electrical fittings made up in the style now known as *l'Art nouveau*. All of the designs which appear in this list are hand wrought, and are stated to lend themselves well for antique finishes, especially oxidised silver and antique brass, of which Messrs. Edwards and Marsden make a speciality. Standards, pendants, brackets, lanterns, electroliers, and ceiling fittings, are neatly illustrated.

The International Electrical Engineering Company, of Clun House, W.C., have forwarded us a set of their illustrated price lists of dynamos, motors, alternators, transformers, switches, controllers, &c., in which a large amount of information is well set out. Efficiencies and power factors are given, and the motors are rated for both continuous and intermittent running, whilst all machine accessories are priced separately. The continuous current motors are listed up to 475 H.P.; dynamos and alternators to 300 KW., and polyphase motors to 210 H.P. A separate seven-page price list gives particulars of the new patent starting switches which the company are placing on the market. These have been specially designed to admit of accurate manufacture in large quantities, and they are arranged for no-voltage and overload release, also for regulating and enclosing in gas-tight covers.

"Electric and Power Pumps" is the title of a special catalogue which has just been issued by the Blake & Knowles Steam Pump Works, Limited, of Queen Victoria Street. The catalogue is of a very convenient size, and is well arranged with a large number of excellent illustrations and details of the many kinds of pumps manufactured by this company.

Claim Settled.—A workman in the employ of Messrs. Macartney, M'Elroy & Co., Limited, of Glasgow, claimed £500 in respect of personal injuries sustained while erecting overhead work for the Possil Road Tramways, his hand being burned by shock. It was announced last week that the pursuer had accepted £15 in settlement of his claim.

Electrical Illuminations.—The Paris Municipality placed the whole of the contract with the Electric Lighting Boards Company for the illuminations in connection with the great Victor Hugo ceremonies on Thursday. These illuminations comprised a temporary installation of no less than 25,000 8-C.P. lights.

Natal.—The values of the telegraph and telephone material imported into Natal during the year ended December 31st, 1901, were £5,060 and £8,320 respectively. The value of the electrical fittings is given as £50,625, and of electrical material (free) as £40,363.

The O'K. Meter Approved.—The B. of T. has approved of the British Thomson-Houston Company's O'K. meter (3 amperes constant pressure direct current).

Spain.—Works are about to be established at Zudaire, Amescoa (province of Navarra), by a French-Spanish syndicate for the manufacture of aluminium electrolytically. Water power is to utilised in the generation of the necessary electrical energy.

Westinghouse Magnetic Brake. — This magnetic brake for electric tramways is gaining favour. Several orders have recently been placed with the British Westinghouse Electric and Manufacturing Company for complete magnetic equipments, among which may be mentioned those of the Glasgow Corporation, 100 cars; the Nottingham Corporation, 16 4-motor cars; and the Tyneside Tramways and Tramroads Company, four large, 4-motor, 80-passenger cars.

Turbine-Propelled Destroyer.—There was launched on the Tyne recently, says the *Times*, a torpedo-boat destroyer designed for steam turbine machinery, and generally of the same type as the *Viper* and the *Cobra*. The new vessel is named the *Velox*, and has not, it is understood, been built to the order of any Government. The hull has been constructed by Messrs. R. & W. Hawthorn, Leslie & Co., at their Hebburn yard on the Tyne, whilst the machinery has been made at the works of the Parsons Marine Steam Turbine Company at Wallsend-on-Tyne. The vessel is 210 ft. long, 21 ft. wide, and 12 ft. 6 in. moulded depth. The main propelling machinery consists of two independent sets of Parsons turbine engines, one high-pressure engine and one low-pressure engine being on each side of the vessel. This gives four turbines, each of which has its own line of shafting, and, as each shaft carries two propellers, there are eight propellers in all. For going astern, reversing turbines are incorporated in the exhaust casing of each of the low pressure cylinders. A novel feature in this vessel is the introduction of ordinary reciprocating engines fitted in conjunction with steam turbines. These engines are of the triple-compound type, are coupled direct to the main turbines, and work in conjunction with them. They take steam directly from the boilers, and exhaust through the high pressure turbine, the exhaust from the latter passing in turn through the low pressure turbine, and from thence to the condensers. The reciprocating engines are for use at cruising speeds, when low power only is needed, and are, therefore, of comparatively small size. As destroyers very seldom run at their top speed, they are apt to be wasteful of fuel during the greater part of their steaming; the new arrangement which Mr. Parsons has introduced should, therefore, be a distinct advantage. When higher powers than those needed for absolute cruising speeds, under ordinary conditions, are needed, steam will be admitted to the turbines direct from the boilers, and when the highest speed is needed, which would bring the rate of revolution beyond that per-

missible with reciprocating engines, steam will be entirely cut off from the latter, they being at the same time thrown out of gear, and the steam turbines alone will be used. With this arrangement the *Velox* will doubtless prove an exceptionally economical destroyer at cruising speeds. The boilers are of the Yarrow type, and have been made by Messrs. Hawthorn. The trials of this vessel will be looked forward to with great interest.

ELECTRIC LIGHT AND POWER NOTES.

Belgium.—A central power station installed in the most modern style has just been completed at Hoboken, a suburb of Antwerp. This station, established in the centre of a group of industries to which it supplies the necessary power, comprises two units of 900 KW. and 400 KW. respectively. The Scheldt being close by, coal is discharged by steamers quite close to the station and mechanically conveyed to the bunkers over the boilers. Automatic stokers are employed.

Bridgend.—The Joint Committee of the County Asylum has decided to take energy for lighting the Angelton and Paregwyllt Asylum from the South Wales Electrical Power Company. The supply for the Asylums and Bridgend will be taken together, so that a lower rate may be obtained.

Cardiff.—The Electrical Committee has endorsed an arrangement made by the borough electrical engineer, Mr. A. Ellis, with Sir John Gunn, on behalf of the Mount Stuart Dry Dock Company, for the supply of light and energy to that firm's works at Bute Docks. This is the first of the big local undertakings to take electrical energy from the Corporation, which supplies on the following terms:—At 1d. per unit with a guaranteed consumption of 50,000 units per annum for every 100 H.P. demanded; 1½d. for a guaranteed minimum consumption of 35,000 units per 100 H.P. per annum; 1¼ per unit same power with guaranteed minimum consumption of 25,000 units per annum.

Clifden (County Galway).—The electric lighting scheme has fallen through.

Coventry.—The E.L. Committee recommends the Council to expend £20,485 for a reserve two-phase plant and further extensions to the works; also that £2,000 be expended upon motors to be hired by consumers.

Dover.—The T.C. has resolved to accept an amended offer from the local electric light and power company for the acquisition of the undertaking for £142,228. The sanction of the Board of Trade to the scheme is being sought. The price accepted is based on the payment of £8 10s. for £5 ordinary shares.

Drayton-in-Hales.—The Market Drayton E.L. and P. Co. is applying to the B. of T. for an electric lighting license for the parish of Drayton-in-Hales.

Epsom.—Although the U.D.C. works have hardly started, applications for 2,013 8-C.P. lamps have been received from private consumers.

France.—A project is on foot for the installation of an electric lighting project for the communes of Lauzun, Eymet, Castillonnès, and Mirmont, in the department of Lot and Garonne.

The commune of Saint-Laurent Grandnaux has just allotted the concession of electric lighting of the commune to M. Vuillet, of Moulins-de-l'Abbaye. The power station, supplied by the Abbaye Lake, will be of 100 H.P., and can at a later date be doubled. In view of the plenitude of waterfalls in the district it is believed that many projects of a similar nature will be carried out in the near future.

Free Town.—The *Handbook of Sierra Leone* states that the local City Council has just granted to a company in England a monopoly to light it with electricity.

Glasgow.—Nine new distributing mains are to be laid by the Electricity Department, at a cost of £2,857, mainly in the Pollokshields district.

Hendon.—The L.G.B. has considered the application of the D.C. for a loan for electric lighting purposes, but having in view the strong opposition to the scheme manifested at the inquiry, has decided to postpone its final decision in order to give the ratepayers a full opportunity of expressing their opinion on the question, in the light of the facts disclosed at the inquiry.

Horsham.—The new electricity works of the U.D.C. were formally opened on 19th inst. The buildings comprise an engine room, a boiler house, and accumulator room. Space is provided for additional machinery, and when further extension is required the present temporary end wall can be easily removed. There are two Babcock boilers, supplied with Hopkinson's fittings, and two feed pumps, one pump being electrically driven. A Green economiser is provided. The two steam dynamos, supplied by Messrs. Reavell and Co., Limited, consist of dynamos constructed by the General Electric Company, Limited, direct coupled to high-speed engines of their own make. These sets are capable of developing 80 and 40 KW. respectively at 450 revolutions per minute, and of giving an emergency load 25 per cent. in excess of the normal load for one hour without injury. Motor-generators and boosters have been provided for battery charging and to regulate the pressure. The storage battery has a capacity of 83 amperes for three hours. Twenty arc lamps are in use for public lighting, and each post is provided with two incandescent lamps, which will be switched on at 11 o'clock. Other streets in the district will be provided with incandescent electric lamps. Mr. W. C. C. Hawtayne is the consulting engineer, and Mr. W. J. Proctor the resident electrical engineer. The following were the contractors for the work:—Buildings, Messrs. Hull & Redford; machinery, Messrs. W. Reavell and Co., Limited; storage battery, Electrical Power Storage Company, Limited; switchboard, Veritys, Limited; overhead crane, Messrs. Carrick & Ritchie; underground mains, Callender's Cable and Construction Company, Limited; arc lamps and posts, W. T. Allen & Co., Limited.

Huddersfield.—The financial statement of the electricity department for the year ended December 31st shows a net surplus of £2,561 16s. 3d. against £110 0s. 4d. in the previous year. It is proposed to transfer the whole sum to the depreciation and contingencies account. The profit is arrived at after allowing £4,342 0s. 11d. interest on loans, £2,722 5s. 6d. towards redemption of debt, and £1,225 7s. 8d. amount repaid Public Works Board. The total income was £20,574 6s. 6d., and expenditure £9,722 16s. 2d., showing a surplus on working account of £10,851 10s. 4d.

Hull.—Sanction has been received from the L.G.B. in respect of the Council's application to borrow £47,900 for the purpose of electric lighting extensions.

Kingston-on-Thames.—The borough electrical engineer has been instructed to take steps to provide 35 new arc lamps for street lighting, and to fit up a number of existing arc standards with incandescent lamps for using after midnight.

Liverpool.—The City Council has approved of the reduction in the charges for electricity supply to 3½d. per unit, as recommended by the E.L. Committee and already detailed in these columns.

London.—CITY.—Last week the Streets Committee presented a report relative to the arrangement for testing electric meters used in the City, and submitted the following for adoption:—"An estimate for the first year's work, the amounts being £1,000, under the agreement with the City of London Electric Lighting Company, and £450 under the Charing Cross and Strand Electricity Supply Corporation's agreement; and a specification and estimate for apparatus, &c., needed for testing continuous current meters, and also for some of the requirements necessary for carrying out the work to be done under the meter-testing agreements, amount £373 10s." The recommendations of the committee were adopted. A letter was read from the City of London Electric Lighting Company, Limited, stating that, pending litigation, they would continue the public lighting for the Corporation on the same terms as heretofore, without prejudice to the rights of either party.

GREENWICH.—The Metropolitan Borough Council has decided to retain the services of Messrs. Handcock & Dykes to advise with regard to electric lighting matters.

WOOLWICH.—The L.C.C. has sanctioned a loan of £6,000 to the U.D.C., repayable in 42 years, to provide for the purchase of the Eltham portion of the Blackheath and Greenwich Electric Lighting Company's undertaking.

Long Eaton.—The Ratepayers' Association has sent a petition to the L.G.B. praying that the application to borrow £15,000 for electric lighting be not granted, owing to the heavy indebtedness of the town.

Maudesley-on-Sea.—A proposal is being considered by the R.D.C. for a scheme of electric lighting submitted by Messrs. Ridout & Co., electrical engineers. Oil engines would be used to drive the dynamos.

Morecambe.—The Electricity Committee is being criticised as to the unprofitable nature of the undertaking, compared with that of Lancaster. The capital up to last year was £35,380 at Lancaster, and £58,200 at Morecambe; the capacity of the plant 420 KW., against 470 KW.; the maximum load observed 366 KW., against 300 KW. at Morecambe; the energy sold last year 324,684 units, against 194,602 units; the financial result being a surplus of £1,178 at Lancaster, against a loss of £677 at Morecambe. The relative works cost per unit for coal, oil, waste and water, wages and repairs, &c., is 2·67d. at Morecambe, against 1·75d. at Lancaster.

Partick.—The new combined destructor and electric lighting station at Mauldslie Street was formally inaugurated on Wednesday last week. The works were commenced in November, 1900, and occupy an area of about 8,000 sq. yds. The destructor consists of six cells and three water-tube boilers. There is also one auxiliary water-tube boiler for use when the destructor cells are not in use. Each boiler has auxiliary furnaces for coal firing in cases of emergency. Forced draught is used throughout, and auxiliary steam jet blowers are provided. About 50 tons of refuse per diem is the present consumption. The engine house contains two 150-KW., and two 75-KW. steam generators, balancer and booster of motor-generator type. It also contains an overhead crane arranged for hand power. The main switchboard is mounted on a special gallery in the engine room. The battery room adjacent contains two batteries of 142 cells, one on each side of the middle wire. The total cost of the combined buildings and plant amounts to £50,000 for the electric lighting plant and £15,000 for the destructor. The street lighting consists of 47 arc lamps mounted on the traction pillars of the Glasgow Corporation tramway system in the majority of cases, while lower down the pillar there are two 16-C.P. incandescent lamps. The various contractors for the work were:—Destructor plant and boilers, Messrs Manlove,

Alliott & Co., Limited; steam pipes, Messrs. Stewart & Menzies; dynamos, balancer and booster, Messrs. Bruce Peebles & Co.; engines, Messrs. Belliss & Morcom; switchboard, Messrs. Mechan and Sons; arc lamps, the Brockie-Pell Company; street mains and cables, the British Insulated Wire Company; battery, the Tudor Accumulator Company; station lighting, Messrs. Kilpatrick & Son, Paisley. Messrs Kincaid, Waller & Manville are the consulting engineers, and Mr. H. B. Maxwell is the burgh electrical engineer. Applications have been received for 7,000 8-C.P. lamps for private lighting, in addition to the public lamps and about 85 H.P. in motors. A luncheon followed the opening, at which many local gentlemen attended.

Pendleton.—A quantity of gas accumulated in one of the manholes in Broad Street, containing electric cable, and became ignited. An explosion followed, and the manhole lid was blown high into the air. No one was injured.

Redruth.—The U.D.C. has accepted the tender of the Urban Electric Supply Company, Limited, for lighting the town with 25-C.P. electric lamps at £1 18s. per lamp per annum, and all-night lamps of 32-C.P. at £2 8s. each, the price to include provision and maintenance, with attendance and renewal, and the running of 30 lamps all night, the contract to be for five years.

Spain.—An electric power transmission plant has lately been put down at the iron ore and calamine mines of the Sociedad Minerà de Mercadal, near Torrelavaga, Spain. Water-power is utilised, and the plant furnishes the power for the operation of the ore-washing machinery, and for the tramway connected with the mines.

Switzerland.—An electric installation has just been completed at Alstœtten-Schonthal for traction and lighting purposes. The current is supplied by two power stations, one worked hydraulically, the other by steam, situated at Weidest and Schonthal respectively. The former station utilises the falls of two water courses, the Bredenbach and the Ebernackquelle. The works contains two sets of turbines, with an alternator of 100 H.P. for the Ebernackquelle, and of 70 H.P. for the Bredenbach catchment. The alternators, running at 2,100 volts and 50 cycles per second, are utilised for lighting at 120 volts. The dynamo is driven by a quadruple compound engine, and supplies the necessary power at 600 volts to a local tramway. The Schonthal station, 2 km. from the other, contains two motors of 50 H.P. and 120 r.p m., driving a dynamo and an alternator. The station is only worked on market days. The tramway referred to is a single line, 11·6 km. in length, and is on the overhead system. The entire installation cost 550,000 fr., and during the year 1900, made a net profit of 61,644 fr., having carried 464,651 passengers.

West Bromwich.—On the working of the new electricity undertaking a deficit of £1,486 has up to the present to be faced. The E.L. Committee and the T.C. having had before it the tenders for the extension of the electricity plant and buildings finds that £8,500 will be insufficient to meet the cost, and therefore recommends that the application to the L.G.B. be amended, and that a sum of £10,000 be borrowed.

Worcester.—The accounts for the year's working of the Corporation electricity works show a profit of £1,385 6s. 2d., by far the largest yet realised. During the first four years the station was worked at considerable loss. These losses fell upon the rates of the city, and will be repaid from time to time as the profits accrue. In view of the profits expected, £500 was appropriated by the Finance Committee to assist the rates, and the remaining £885 6s. 2d. will be placed to reserve.

Worksop.—The U.D.C. has decided to rescind the resolution fixing the price at 5d. per unit, and has substituted 4d. per unit, with the usual discount.

ELECTRIC TRACTION NOTES.

Aberdeen.—The Corporation have entered upon a contract the completion of which will inaugurate the electrical working of the whole of the city tramways. Some apprehension was felt in regard to the section along Union Street, which is the finest thoroughfare in the city, lest the erection of poles for the suspension of the necessary wires for trolley traction would prejudicially affect the amenity of the street, but owners of property have come pretty freely to the rescue, and by allowing the Corporation to fix rosettes on their building frontages the results have been quite satisfactory. The work of equipping electrically the lines at present being used for horse cars is in full swing, and it is expected that by early summer horse haulage will have been entirely abandoned. The cost of the works now in progress is estimated at something like £50,000, and by the time the whole of the system is in electrical operation it is anticipated that the capital charge standing against the tramway department will have reached a sum pretty near £290,000, which is the limit of the Corporation's borrowing powers in this direction. Meantime a syndicate is asking Parliament for powers to construct an electrically-equipped tramway from the northernmost boundary of the city to one of the suburbs on the River Don, and a similar line from the south-western city boundary, along the Deeside highway to Cults, another popular residential suburb. While the Great North of Scotland Railway Company are to offer strenuous opposition to the proposed new lines of tramway, as the latter would enter into competition with the company's suburban train services, both the Town Council and County Council are prepared to come to terms with the syndicate. According to an agreement decided upon, the latter shall be bound to sell their system to the Town Council in the event of its coming within the boundary of the city. The latter is a very probable eventuality in view of the rapid growth of Aberdeen during the past decade or two.

Barnes.—The U.D.C. last Friday evening considered a voluminous report on tramway matters. The London United Company offer to widen the local thoroughfares at various points at a total estimated cost of no less than £100,000, the route being from the Richmond boundary, Lower Richmond Road, Kew Lane, Mortlake Green, High Street (Mortlake), White Hart Lane, Barnes High Street, to Hammersmith Bridge. The suggestions of the Council's surveyor have been nearly all accepted by the company, and the trees along the Terrace are to be left. On the other hand, the Council agree to extend the purchase period from 25 to 50 years, and they consent to the trolley system.

Barrow.—Last week a Corporation Committee visited London with a view to coming to an arrangement with the B.E.T. Co., by which the company would be able to work the Barrow tramways. An arrangement was come to under which the company will obtain a lease of the lines for 26 years.

Batley.—It is stated that the B.E.T. Company will pay the Batley Corporation about £1,500 to recoup them for their expenses incurred in obtaining Parliamentary powers to construct tramways within their borough.

Belfast.—In addition to the Corporation, the railway companies, the Water Commissioners, &c., &c., of Belfast, are opposing the Bill for the electric equipment of the Whitewell and Cavehill tramway.

Brentford.—The U.D.C. have resolved to ask for an apology from the person responsible for the publication of a certain handbill reflecting on the Council's policy with regard to the speed of the L.U.T. trams.

Dublin.—The case of Mrs. Catherine Lynch *v.* Lucan Electric Tram Company, which had been at hearing before the Lord Chief Baron and a city common jury, in the King's Bench, Dublin, was concluded on Wednesday last week. Mrs. Lynch sought damages to the amount of £3,000, for injuries received while travelling on the company's line in July last. The jury found for the plaintiff and assessed damages at £500.

Hounslow and Slough.—The Earl of Jersey, Colonel G. F. O. Boughey, Mr. H. A. Steward, and Viscount Emlyn (as secretary) held a L.G.B. inquiry at Windsor on Feb. 14 to consider the application of the Metropolitan District Electric Traction Company for a light railway order for a line from Hounslow Barracks, along the Bath Road, to Slough and Datchet. Mr. R. D. M. Littler, K.C., appeared for the promoters, and there was a strong opposition from the L.S.W.R., G.W.R., L.U.T., Middlesex and Buckingham County Councils, and the U.D.C's. of Bedfont, Datchet, Eton, Heston-Isleworth, Slough, and Staines, as well as from several frontagers. It was stated that the originator of the proposal was Mr. Yerkes. As to the engineering of the scheme, Mr. Littler said the company would make a gentle sloping bridge at the level crossing over the West Drayton Railway, but there was a difficulty at Colnbrook Village, where the road was at places only 16 ft. wide; and they could not deviate either way, because the route ran nearly through the centre of Colonel Meeking's estate. He went on to deny that the Middlesex County Council had any *locus standi*, but admitted, amid laughter, in reply to a question, that he was himself the chairman of the Council. Sir Alexander R. Binnie, the company's engineer, in giving evidence, said it was not proposed to work through traffic with the District Railway, on account of the difficulty of designing suitable rolling stock. As to the Colnbrook difficulty, they did not object to a suspension of two years, in order to negotiate for the purchase of land. On the witness saying that the company would be prepared to take separate orders for lines from Hounslow to Colnbrook, and from Colnbrook to Slough, Lord Jersey said that the Commission certainly could not allow a line either through or beyond the village, and the rest of the hearing was occupied with questions relating to the Hounslow and Colnbrook portion. After nearly six hours' legal arguments, Lord Jersey said no provision had been made for widenings, and it was therefore unnecessary to proceed further with the application.

Notices are being issued for an application by the L.U.T. for a light railway from Hounslow to Windsor Road, Slough, *vid* Cranford and Colnbrook, and for a branch line to Datchet.

Huddersfield.—Twenty-five new cars have been ordered. They are much lighter than the ones at present in use, and run on four wheels instead of two bogies of four each, which have been found too heavy and otherwise unsatisfactory for the steep gradients.

Hull.—The tramcar guards employed here having been declared by the Board of Trade to be ineffective, the matter came before the Tramways Committee last week. It was stated that if all the cars were to be fitted with new guards the cost would be about £5,000. The engineer and the chairman of the Committee are to bring up a report on the matter.

Johannesburg.—The High Commissioner has sanctioned the local electric tramway scheme. The re-organisation and extension of the electric light and power station, and the construction of electric tramways will involve, it is estimated, an expenditure of between £300,000 and £400,000. An electrical engineer is to be specially engaged for the purposes of consultation in the matter.

Kearsley.—Last week the Board of Trade inspector passed the electric tram line which has been constructed for the Kearsley U.D.C., by whom it has been leased for 21 years to the Farnworth D.C. It has been constructed to the plans and under the supervision of Messrs. Lacey, Clirehugh & Sillar. It is 1¾ miles long, and brings nearer a through service of electric cars between Salford and Bolton, which will be an accomplished fact as soon as the remaining section from Clifton to Pendlebury is completed. It consists of a single line, with loops at intervals, with the poles in the centre, similar to those erected in Salford. Later on the line will be doubled the whole of the way. The stiffest gradient in the section is 1 in 20. The contract for the overhead work was let to the British Insulated Wire Company; the centre poles were supplied by Messrs. Russell, of Wednesbury; and the cars by the Westinghouse Company and Messrs. G. F. Milnes & Co.

Lancaster.—A deputation from the Lancaster and District Tramways Company has met a deputation of the Electric Tramways Committee of the Corporation with a view to the sale of the Lancaster—Morecambe line. The matter has been deferred pending a definite offer from the tramway company. The tramways engineer has commenced operations in laying the new electric line to Scotforth and Williamson Park.

Manchester.—We understand that last week representatives of the Tramways Committees of Manchester and Salford conferred privately at the Manchester Town Hall with the object of narrowing the points at issue between them with regard to the future working of the two electric tramway systems. Various points were discussed, but no definite result was arrived at.

Middleton.—The T.C. has decided to authorise the Manchester Corporation to construct the permanent way for the tramways between Middleton and Blackley.

Mitcham.—The B.E.T. Co. have practically acceded to the Croydon R.D.C.'s suggestions *re* widenings, and also offer £1,000 for the Mitcham Light Railway order.

New Malden.—The U.D.C., at a special meeting last Saturday, considered a voluminous report on tramways, which was adopted after discussion. It provides for the sanctioning of the L.U.T. line through Malden, to connect Kingston and Wimbledon, without touching the residential district of Coombe.

North Down.—The construction of the North Down electric tramway has been authorised by the Irish Privy Council. The promoters of the undertaking are the National Electric Traction Company, Limited. The principal line is from Bangor (which is connected by rail with Belfast) to Donaghadee—both fashionable seaside resorts. Other special lines are to Bullyholme Bay, the new pier, Seacliffe Road, Bulloo Lower and Orlock Lower. The lines are to be finished and ready for traffic by January 1st, 1904.

Oldham.—The majority of the property owners and occupiers on the westerly side of St. Domingo Street are assuming a very firm attitude in their opposition to the policy of the Oldham Corporation in laying double tracks in the street. They have placed their case in solicitors' hands, and an action was commenced last week on their behalf against the Corporation, by the serving of a writ returnable in the Chancery Court upon the town clerk of Oldham. The plaintiffs to the action are William Perkins and F. K. Goodall and their tenants. They claim an injunction to restrain the defendants from taking up the single line of tramways and re-laying the same as a double line, contrary to the provisions of Oldham Corporation Act, 1899, Sec. 34, and to restrain the defendants from keeping and maintaining the said tramway as a double line so that a less space than 9 ft. 6 in. shall intervene between the outside rail of the said tramway and the outside of the footpath on the westerly side of the said street opposite the houses, shops, and premises situated and numbered 40, Manchester Street, and 1, 3, 5, 7, and 9, St. Domingo Street, "the said plaintiffs," the writ proceeds to recite, "being more than one-third of the owners, and more than one-third of the occupiers of the premises abutting on the place where such less space intervenes." The plaintiffs also seek an injunction to restrain the defendants from running trams on such lines, and claim damages by reason of the obstruction of the said street and the interference with the access to the premises of the plaintiffs. The single line of track mentioned, has been taken up, and the double track laid, and ready for the running of cars.

Sunderland.—Mr. F. J. Trewhitt, the chairman of the Tramways Committee, has just drawn up an estimate of the income and outlay in connection with the borough tramways for the year ending March 31st, 1902. This shows that the Committee commenced the year with a credit balance of £4,757 12s. 10d., and the traffic receipts, rents, and interest total £66,300, making a gross estimated income of £61,057 12s. 10d. Against this there stand the following items of expenditure:—Electric current, £10,300; drivers and conductors, £9,700; management and office expenses, £1,600; inspectors and cleaners and other staff, £3,600; rents, rates, and taxes, £1,400; insurance, £120; shed stores, £800; tickets and uniforms, £400; compensation fund for injury, £700; repairs and renewals, £5,750; interest, £6,811; sinking fund, £6,712; reserve fund, £5,000; total expenditure, £52,893, leaving a net profit of £8,164. The report has given great satisfaction to all shades of public opinion, more particularly the suggestion that the sum of £7,000 should be handed over to the Finance Committee to be given to the reduction of the local rates. £7,000 represents about 3d. in the £. This proposal has not yet been considered by the Council.

Tees-side and Cleveland.—The Imperial Tramway Company, Limited, whose service of electric cars connects Middlesbrough, Thornaby, and Stockton, have in contemplation considerable extensions to their system by the construction of tramway lines to connect Middlesbrough with North Ormesby, South Bank, and Grangetown. The need of some easier and more frequent means of communication between these rapidly growing townships themselves, and between them and the populous town of Middlesbrough has been greatly felt for a number of years past. The North-Eastern Railway Company, owing to its geographical position, cannot adequately satisfy the needs of these important environs of Middlesbrough. Mr. Clifton Robinson some two years ago outlined a scheme for extending the Tees-side system through North Ormesby and South Bank to Eston. That scheme, however, was rendered nugatory, at least for a time, by two serious obstacles. The first was the immense difficulty of carrying the tramway over the railway level crossing at North Ormesby, and the second the enormous expense that would have to be incurred in connection with the toll bar in the same locality. Accordingly nothing was heard of the scheme until a few days since, when Mr. Barnley, solicitor to the Tramways Company, laid before the North Ormesby District Council details of an amended scheme, the main features of which are that the present tramway system would be taken through Grove Hill and into North Ormesby by means of an entirely new road at Breckon Hill and a bridge over the railway. This scheme, it appears, will be submitted to the Light Railway Commissioners in May next. There will be considerable developments, too, on the Durham side of the River Tees. A line will be made from Stockton to Portrack, Billingham and Port Clarence, and a further extension will be made from the Port Clarence ferry to Seaton Carew and Hartlepool. The latter scheme, it is stated, is intended to be a connecting link between the Middlesbrough system and the north side extension, and involves the consideration of either bridging or tunnelling the River Tees.

TELEGRAPH AND TELEPHONE NOTES.

American Pacific Cable.—The Washington correspondent of the *Standard* reported on 20th that the debate on the Pacific Cable was developing a disposition to oppose the Commercial Cable Company's proposal, "because it is in the nature of an alliance with the Eastern Extension Company's monopoly. Representative Corliss cited the Commons' Debate in support of his contention that this monopoly is prejudicial both to England and the United States."

Cable Rates to India.—The *Times* on 21st inst. said:—"When we announced that the cable rate to India was to be reduced on March 1st to 2s. 6d. a word, we said that this implied that the assent of Germany and Russia to the change had been obtained. It appears that the matter was taken in hand by the British Government. The German Government resisted the proposed reduction because they wanted facilities for a cable at Valencia. The opposition of Russia seems not to have caused much trouble. Both Powers have now agreed to the reduction of rate."

In the House of Commons, Sir E. Sassoon asked the Secretary for India whether it was proposed to delay taking any steps concerning the Joint Purse Agreement and the Australian Message Fund, in which India was a partner with the Eastern, the Indo-European, and the Eastern Extension Companies, until after the House had had the opportunity of considering the final report of the Inter-Departmental Committee on Cable Communication, and could he say when it was expected that this final report would be issued; and whether he would arrange to issue a detailed account of the recent negotiations between the Indian Government and the companies, which had resulted in a reduction of the Indian rate to 2s. 6d. Lord G. Hamilton replied: It is not proposed to interrupt or delay the negotiations which have, for some time past, been in progress with regard to a date for the determination of a Joint Purse Agreement, and of the Australian Message Fund. I do not know when the final report of the Inter-Departmental Committee will be issued. It is not proposed to publish any account of the negotiations which have led to a reduction of the Indian rate.

Cape—Australian Cable.—The laying of the last section—between Perth and Adelaide—of the Cape—Australian cable has now been successfully completed and will be open for traffic on 1st prox.

Eccles Telephones.—At a meeting of Eccles ratepayers last week, a resolution, moved by the Mayor in favour of the Manchester and Salford Telephone Board, was defeated by a large majority, and a poll of ratepayers was demanded.

Post Office Telephones.—On Monday the new Post Office telephone system for London was put into operation at the Central Exchange, Carter Lane.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899 ..	..
Para-Maranham	March 1, 1900 ..	..
Alexandria-Laruaca	Jan. 19, 1902 ..	..
Assab-Massowah	Feb. 18, 1902 ..	..
Modica-Malte	Feb. 25, 1902 ..	..
Fao-Bushire	Feb. 25, 1902 ..	..
Landlines :—		
"*Via* Hanekin" on Persian territory	Feb. 24, 1900 ..	..
Communication with Baranquilla and Cartagena	Dec. 8, 1900 ..	..

Telegraph Rates to Ceylon.—The Indo-European Telegraph Company announces that the tariff to Ceylon will be reduced from 4s. 1d. to 2s. 7d. per word on and after 1st prox.

The Telegraph Service.—In the Commons on Tuesday, in reply to Mr. Henniker Heaton, Mr. Austen Chamberlain said (according to the *Times*) there was recently here and there some difficulty in obtaining an adequate supply of telegraph messengers, but the Postmaster-General has no reason to think that there has been any general delay in the delivery of telegrams or any general want of care on the part of his officers in transmitting telegrams. If, however, my hon. friend will forward to the Postmaster-General the information on which his question has been based inquiry will be made. The number of skilled telegraphists withdrawn for service in South Africa has somewhat diminished the efficiency of the staff at the offices affected, but apart from this the Postmaster-General does not think the telegraph offices are undermanned.

Underground Telegraphs.—It is reported that the Postmaster-General has consented to receive a deputation from Glasgow with respect to the proposed underground telegraph cable between London and Glasgow. March 6th has been fixed for the reception of the deputation, which will be supported by the City members of Parliament.

Wireless Telegraphy in Italy.—The Minister of the Marine has decided to place the Italian capital and Sardinia in communication through the agency of wireless telegraphy. An order has already been placed for the necessary apparatus for the installation of wireless telegraphy on board the Italian men-o'-war.

Wireless Telegraphy.—*Indian Engineering* says that experiments with Marconi's wireless telegraphy will probably shortly be made at Minicoy in the interests of shipping. Messages will be flashed from Minicoy probably to Calicut, for transmission to other parts of India and Ceylon. The Board of Trade is arranging matters.

The Berlin correspondent says that the German Government intends to lay a Bill for obtaining the greatest possible uniformity in the use of wireless telegraphy before the Reichstag as soon as possible. Signor Marconi has declined the invitation of the German Government to take part in the competitive trials between the two German systems of spark telegraphy—that invented by Count Arco and Prof. Slaby, called the German Universal Electricity Company's system, and that invented by Prof. Braun, of Strasburg, known as the Siemens & Halske system—which commenced at Kiel a few days ago, with a view to ascertaining which of the two methods is to be adopted by the Imperial German authorities. It is said that, while Signor Marconi had established trustworthy communication to a distance of 150 kilometres, the German Universal Electricity Company has done so with its own apparatus to a distance of from 150 to 160, and even, with absolute perfection, as far as 200 kilometres. It hopes to be able to increase the distance to 350 kilometres. What progress the use of wireless telegraphy has made in the German Marine is best shown by the fact that 32 of its largest ships are provided with such apparatus, and that for eight more the apparatus will be ready by March 1st at the latest.

Some trials with a system of wireless telegraphy, devised by Senor Cevera, have lately been made between Ceuta and Tarifa, in the province of the Chief of Telegraphs, in Spain. The tests are stated to have given very satisfactory results.

An Ottawa press dispatch, dated February 26th, states that the agreement between Mr. Marconi and the Government was laid on the table in the Dominion House of Commons on that day. It provides that the Government shall grant a sum of $80,000, that a wireless telegraphy station shall be erected at Cape Breton, and that the company which is to work the new system shall transmit messages at a *maximum* rate of 10 c. per word for commercial messages and of 5 c. for press messages. The Government is also to have the use of the system for coast signalling. If Lloyd's declines to agree to the use of the system, then the grant is to be reduced to $50,000.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—March 6th. Twelve double-deck single-truck cars and equipments for the Corporation. See "Official Notices" February 14th.

Aberdeen.—March 6th. Overhead equipment, bonding, and cables for the Corporation tramways. See "Official Notices" February 14th.

Belgium.—March 1st. The municipal authorities of Ghent are inviting tenders until the March 1st, 1902, for the concession for an electric lighting installation. See our "Official Notices" January 3rd.

Belgium.—March 1st. Tenders are being invited until March 1st by the municipal authorities of Braine l'Alleud for the concession for the electric lighting of the town. Tenders are to be sent to Le Secretariat Communal de Braine-l'Alleud, whence particulars may be obtained.

Bournemouth.—March 8th. Traction and arc lighting switchboards for the Corporation. See "Official Notices" Feb. 21st.

Bournemouth.—March 15th. Coal and ash conveyors, bunkers, &c., for the Corporation tram station. See "Official Notices" this week.

Boston.—Firms willing to carry out the Council's electric lighting and tramways order are invited to communicate with the chairman of the Lighting Committee. See "Official Notices" to-day.

Brighton.—March 24th. Telephone cables, conduits, poles, instruments, wires, batteries, switchboards and various other materials for Corporation telephone system. See "Official Notices" to-day.

Burgess Hill.—March 12th. Offers for the construction of electricity works are invited by the U.D.C. For conditions, &c., see our "Official Notices" February 14th.

Dewsbury.— March 10th. The Corporation wants tenders for cooling tower and pond, piping, valves and tanks, and centrifugal pump and motor, at the electricity station.

Edinburgh.—March 3rd. Electric lighting installation for the third portion of the Colinton Mains Fever Hospital (600 points) for the Council. See "Official Notices" February 7th.

Elland.—March 11th. Engines, dynamos, booster and balancers, battery, switchboard, cables, crane, and condensing plant. See "Official Notices" February 21st.

France.—March 13th. The French Post and Telegraph Authorities in Paris are inviting tenders until March 13th for the supply of 330 tons of bronze wire. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Ghent.—March 20th. The latest date for sending in tenders for the establishment of electrical works has been extended to March 20th. The original advertisement appeared in our "Official Notices" on January 3rd.

Hackney.—April 9th. Three water-tube boilers, water softener, &c., for the electricity works. See "Official Notices" to-day.

Heckmondwike.—March 15th. Piping, traction generator, battery and booster, switchboard work, condenser, cooling tower, feeders, &c., for the U.D.C. See "Official Notices" to-day.

Ilford.—March 11th. Twelve months' supply of meters, fuse boxes, lamps, stores, cables, and jointing materials. See "Official Notices" to-day.

Ilford.—March 24th. Cars, trucks, motors and equipments. See "Official Notices" February 21st.

London.—March 4th. The L.C.C. is wanting tenders for 100 or 50 double-deck double-bogie tramcars for conduit lines in South London. Drawings, &c., at the County Hall, Spring Gardens, S.W. (£3).

Manchester.—March 1st. Corporation Tramways Committee advertises for life guards for tramcars, &c.

Manchester.—March 3rd. The Rivers Committee invites tenders for electrical goods, &c.

Manchester.—March 10th. Corporation wants tenders for electrical equipments and trucks for cars. See "Official Notices" February 21st.

Oban.—March 7th. Piping, balancing transformers, and motor-generators, battery, switchboard, arc lamps, cable work, and crane for the Corporation electric lighting. See "Official Notices" February 14th.

Oban.—March 7th. Conduits, manhole covers, arc lamp-posts, &c. See "Official Notices" February 21st.

Oldham.—March 25th. Piping, pumps, tools, &c., for the Greenhill electricity station. See "Official Notices" to-day.

Oulton.—The Mutford and Lothingland Board of Guardians are considering the question of providing an electric light installation for the workhouse at Oulton.

Pontypridd.—March 7th. Overhead equipment and bonding for the U.D.C. tramways. See "Official Notices" February 14th.

Rockhampton (Australia).—March 31st. The Council of the Municipality of Rockhampton is prepared to consider applications from companies desirous of undertaking the construction and working of a system of electric tramways under the Queensland Tramways Act of 1882, and the Amendment Act of 1890. See Electrical Review, January 10th.

St. Pancras.—March 14th. Overhead travellers for the Council. See "Official Notices" to-day.

Salford.—March 1st. Twelve months' supply of materials for the Electricity Department, including cables and accessories, fuse boxes, meters, joint boxes, carbons, &c. Mr. C. D. Taite, borough electrical engineer. See "Official Notices" February 21st.

Salisbury.—March 4th. The directors of the L. & S.-W. Railway want tenders for the electric lighting of Salisbury station. See "Official Notices" February 14th.

Southend-on-Sea.—March 6th. Tenders for two storage batteries. See "Official Notices" February 21st.

Stalybridge.—March 3rd. Rails, points, crossings, tie-bars, bolts, trolley wire, &c., for the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board. See "Official Notices" February 14th.

Sunderland.—February 28th. Lathe, drilling, and shaping machines, and other workshop tools for the Corporation electric lighting department. See "Official Notices" Feb. 14th.

Swansea.—March 8th. Two 600-KW. steam dynamos, &c. See "Official Notices" February 21st.

Wakefield.—March 13th. Lancashire boiler, economiser, feed pump, for the lighting works. See "Official Notices" to-day.

Wallsend.—March 19th. The Council wants tenders for a refuse destructor, electric lighting machinery, electric crane and motor for driving same. The destructor must be capable of dealing with 300 tons of ashpit, privy and general town refuse per week. Pug mills to grind the resulting clinker. The electric lighting machinery to light the destructor and adjacent street and public quay. The crane, to lift 5 tons, is to be erected on the quay. Mr. George Hollings, borough surveyor.

Wimbledon.—March 11th. Year's supply of stores, cables, transformers, meters, lamps, &c., for the Electricity Department. See "Official Notices" to-day.

CLOSED.

Aberdeen.—The following contracts have recently been placed by the Tramways Committee:—Poles, A. and J. Stewart and Menzies; overhead wirework and bonding, B.I.W. Co.; cables, Anchor Cable Company.

Huddersfield.—The British Westinghouse Electric and Manufacturing Company, Limited, have received the order for complete electrical plant for 25 tramcars. The equipments will consist of 49 B motors, No. 90 controllers, automatic circuit breakers, and resistances for "service" braking.

Llandudno.—The U.D.C. has accepted the tender of Messrs. Crompton & Co., Limited, Chelmsford, for the extension of the electric lighting works, as required, for the sum of £2,809. Messrs Crompton's tender was not the lowest, but was the lowest approved tender out of 30.

Portsmouth.—The contract for the electric lighting and other electrical work connected with the new naval barracks at Portsmouth has been entrusted to Messrs. Bergtheil & Young. The building contract was one of the largest building contracts ever given to one firm, and we hear that the electric lighting is in proportion.

Norwich.—The Norwich Electricity Company, Limited, have accepted the tender of the Electrical Power Storage Company, Limited, for the storage battery for their generating station at £1,771.

West Bromwich.—The E.L. and P. Committee have accepted the following tenders:—Messrs. Babcock & Wilcox, for two boilers and accessories; Messrs. Parsons & Co., for two steam dynamos and surface condenser; Messrs. Cowans, Limited, for boosters, switchboard, and connections; and Mr. John Mallin for the extensions to the buildings.

FORTHCOMING EVENTS.

Friday, February 28th.—At 8 p.m. Institution of Civil Engineers. Students' Meeting. Paper to be read: "Indicating High-Speed Steam Engines," by A. M. Arter.

At 8 p.m. Electro-Harmonic Concert. Ladies' night.

Saturday, March 1st.—At 3 p.m. Royal Institution. Lecture by Rt. Hon. Lord Rayleigh, F.R.S., on "Some Electrical Developments." (Lecture III.)

At 10.30 a.m. Institution of Electrical Engineers (Students' Section). Visit to the generating station of the London United Tramways Company, Chiswick.

Monday, March 3rd.—At 7.30 p.m. Society of Engineers. Meeting at the Royal United Service Institution, Whitehall. Paper on "British *v.* American Patent Law Practice and Engineering Invention," by Mr. B. H. Thwaite.

Thursday, March 6th.—At 7.30 p.m. Institution of Electrical Engineers (Dublin Section). Meeting at the Royal College of Science, Stephen's Green. Adjourned discussion on paper: "Notes on Irish Water-Power and its Electrical Development," by W. Tatlow, M.A., B.E.

At 8.30 p.m. Röntgen Society. Meeting at 20, Hanover Square. Paper by Dr. Barry Blacker on "Localisation; With Demonstration of a Simple Direct Reading Apparatus."

At 8 p.m. Electrical Trades Union (Battersea Branch). Organising Concert will be held at the "Meyrick Arms," Clapham Junction.

Saturday, March 8th.—At 3 p.m. Royal Institution. Lecture by Lord Rayleigh on "Some Electrical Developments." (Lecture IV.)

Monday, March 10th.—Institution of Electrical Engineers (Newcastle Section). Meeting. Paper by C. S. Vesey-Brown on "Electrical Power Supply on the North-East Coast."

Tuesday, March 11th.—At 7.30 p.m. Institution of Electrical Engineers (Manchester Section). Meeting at Owens College. Paper on "Electric Tramcars and their Equipment," by W. G. Rhodes.

At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting at the Institute of Engineers and Shipbuilders.

Wednesday, March 12th.—At 7.30 p.m. Institution of Electrical Engineers (Birmingham Section). Meeting in the Physical Theatre of the University.

NOTES.

A Hint to Electrical Illumination Manufacturers.—We commend the remarks contained in the following letter to the urgent attention of manufacturers who are laying themselves out to meet the coming demand for Coronation electrical devices and fittings. No doubt the mere mention of the matter will be enough to lead to every station engineer in the kingdom being deluged with circulars and catalogues forthwith:—

"It appears to me that the British section of electrical manufacturers are sadly deficient of the energy and ingenuity that is necessary for a progressive nation. This is made apparent by the fact that, whilst gas managers are being inundated with catalogues and illustrations of gas illuminations for the Coronation festivities, the electrical engineer has not yet seen any efforts made in this direction.

"I should be very pleased if you would direct attention to this matter in your valuable paper, and I, for one, would be very glad to learn if any firms are moving in this line. Thanking you in anticipation.

"I am, yours faithfully,
"JOSEPH BOYCE, *Chief Assistant.*"

Darwen Electricity Works.

Personal.—Mr. J. R. Cowell, M.I.E.E., M.I.M.E., is resigning the position of manager and engineer of the light and power department of Johannesburg to join the firm of Blane & Co., Limited, of that town, engineering contractors and importers, as engineer to the firm, especially with the view of developing an electrical branch of their work. Messrs. Blane & Co. have been established in Johannesburg some eight years. In addition to the agencies now represented by the firm, it is proposed to represent electrical appliances of good firms, and Mr. Wm. Blane was to leave Johannesburg last month by ss. *Briton* for the purpose of arranging matters of this kind. His address will be—care of African Banking Corporation, Limited.

Lecture.—On Thursday last week, at Carpenters' Hall, E.C., Prof. J. A. Fleming lectured on the "Transmission of Light and Electricity."

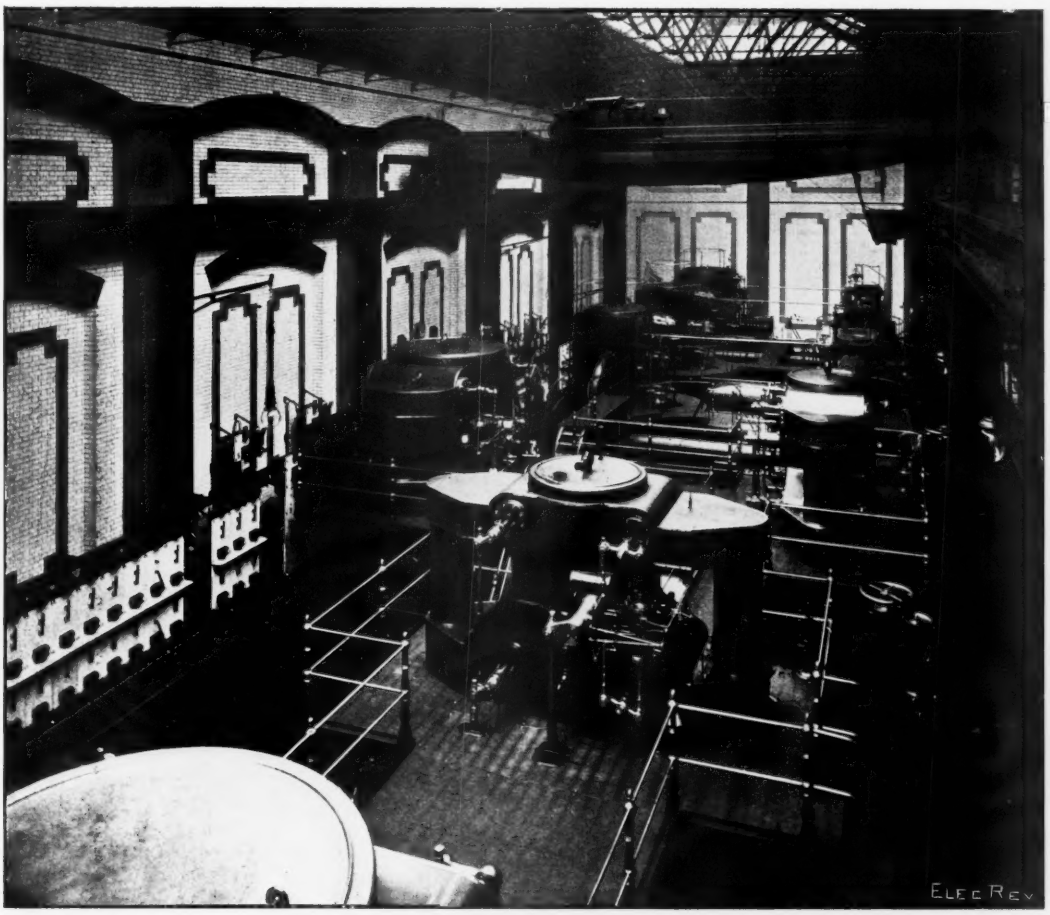
Tramways and Observatories.—A daily paper says that the Nice Electric Tramway Company is defendant in a suit for damages brought by the founder of the Nice Observatory. The plaintiff asserts that the instruments in the magnetic observatory, close to which the trams run, have been rendered useless, and he has been forced to erect another observatory at a cost of £4,000.

Obituary.—We regret to record that Mr. H. R. Low, the electrical engineer to the Cape Town Corporation, died a few weeks ago. Mr. Low was at one time with the Brush Company, and also connected with the Woolwich undertaking. He went to the Cape under medical orders about 1895, and joined the firm of Findlay & Co., of Cape Town. On the retirement of Mr. E. G. Jones, in 1896, Mr. Low accepted the post of electrical engineer to the Corporation of Cape Town. Shortly after taking over this position, he altered the five-wire 440-volt system to the three-wire 440, and introduced the 220-volt lamp, and also extended the existing power plant by the erection of an additional power station. Mr. Low had only just returned from Europe, where he had been engaged in selecting two large steam sets for the Cape Town generating stations. The deceased gentleman was born in India, and was a nephew of Sir Robert Low, who commanded the Anglo-Indian forces in the Chitral campaign. He was an associate member of the Institution of Electrical Engineers.

(*Continued on page* 351.)

The New Direct Current Works of the City of London Electric Lighting Company.

THREE years ago we published an illustrated description f the huge high pressure alternating current generating ation, containing plant of 11,000 KW. capacity, of the ity of London Company at Bankside.* Even at that ate, the company had begun to instal direct current plant, nd it is worthy of note that since 1898 all extensions have een carried out by the company on the direct current stem. The generating plant installed for this purpose in fact, in order to carry out recent extensions it was found necessary to purchase practically the whole of one side of Sumner Street. This purchase was carried out partly by agreement, but partly under compulsory powers by special Act of Parliament, and having regard to the magnitude of the undertaking, it is remarkable to find that, within the space of three years, one of the largest continuous current generating works in this country has been successfully established,



General View of Station.

has now attained to very considerable dimensions, and possesses so many features of interest that we are glad to avail ourselves of the kind permission of the engineer-in-chief, Mr. Frank Bailey, to place a short description of it before our readers.

It will be seen from the general plan, which we publish on p. 348, that the works occupy a site of considerable size; not only in the face of all ordinary difficulties, but also in spite of every obstacle which the powerful Corporation of the City of London could thrust in the way of the company.

A handsome building has been constructed, and now contains its full equipment of continuous current generators; the building having been designed to accommodate the plant, there is no waste space, and just sufficient room is left surrounding each engine to allow for the removal or repair of any part. Land is, of course, very valuable on a site so

* See Electrical Review, March 3rd, 10th and 17th, 1899

near to the centre of the city, and it is highly creditable to the engineer that plant capable of giving an output of over 7,000 KW. has been so conveniently placed within the limited space available.

The generating plant is all of the standard tramway type, each set consisting of a dynamo mounted on the shaft between the cranks of a two-cylinder compound engine; it is interesting to note that, although the company are fully satisfied with all their high speed alternating plant, they now prefer to adopt the low speed Corliss type of engine, coupled to direct current generators of a size not usually met with in electric lighting stations.

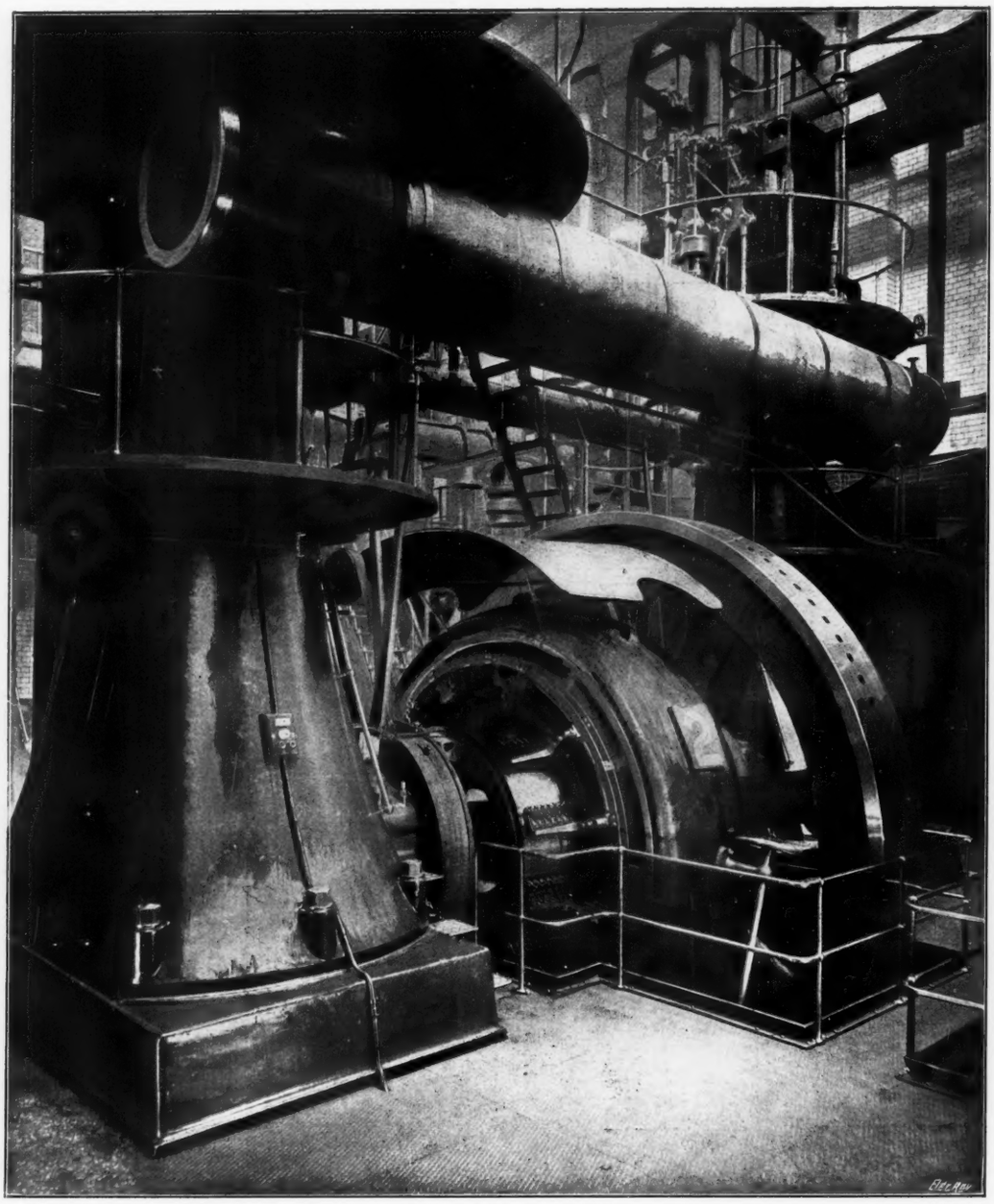
The first instalment of plant consisted of three Allis-Westinghouse 1,000 KW. generators; two Musgrave-Westinghouse 2,000 KW. generating sets were added last year.

The Allis engines are of the standard vertical cross-compound condensing type adopted by this firm, the diameters of the cylinders being 28 in. and 60 in. × 48 in. stroke, and they run at 90 r.p.m. The crank shafts are of wrought-iron, 24 in. in diameter; the fly-wheel is 18 ft. in diameter and weighs nearly 50 tons.

The Musgrave engines give a maximum of 4,100 I.H.P.; the diameters of the cylinders are 38½ in. and 76 in. × 54 in. stroke, and the speed is 75 r.p.m. The crankshaft is of mild steel and is 28 in. in diameter, the fly-wheel being 24 ft. in diameter and weighing about 80 tons.

We have here, therefore, two standard types of engines, each being probably representative of the best of their respective countries, working side by side under the same conditions, and it is interesting to note the simplicity of design, coupled with the massive construction of the English engines—features which have always been characteristic of the best British work, whether in machine design or in the building of an Empire.

Surface condensers are used, with air pumps of the Edwards type; in the case of one of the Musgrave engines, the air pump is worked direct from the engine motion, while



Allis-Westinghouse 1,000-kw. Generating Set.

in the case of the other sets, separate air pump engines have been supplied by Messrs. De Ritter.

The water consumption of these generating sets varies from 20 to 22 lbs. per kilowatt-hour. The use of such large generators has suggested the desirability of securing safety by the addition of various forms of emergency governors and valves, the latter of which can be operated by hand if required.

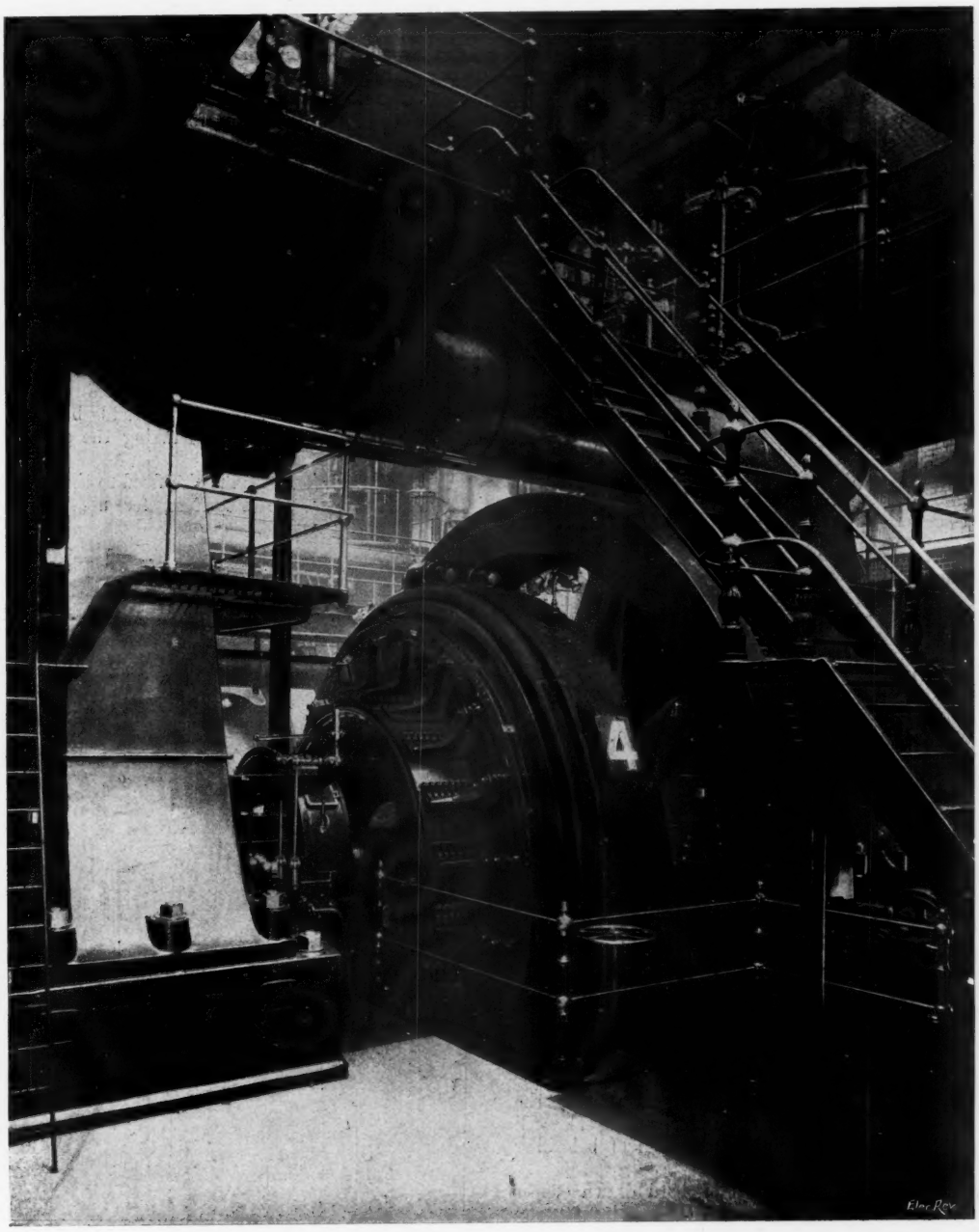
The Westinghouse generators are all multipolar, and the armatures being provided with compensating windings, the machines run with an absence of sparking under all conditions.

The field magnet consists of a cast-iron ring carrying 20 pole-pieces projecting internally; the latter are built up of soft steel stampings cast into the field ring. The field ring is divided vertically, and the halves are mounted on guide plates, so that they can easily be drawn apart. All parts of the armature and field are by this means readily accessible for inspection or repairs. The machines are all self-exciting.

The total height of the 2,000 KW. machine is about 21 ft; its length along the shaft 5 ft. 3 in.; and its extreme width about 26 ft. The height of the machine above the floor line is about 9 ft. 6 in. The armature is built direct on the engine shaft, between the high pressure and low pressure sides, and close beside the massive fly-wheel.

The armature and the commutator are both built on one cast-iron spider, which is cast in four sections with two spokes or legs to each section. The hub is 37½ in. deep, accurately bored to fit the shaft, on to which it is pressed over the key. Two rings are afterwards shrunk over each side of the hub, the diameters outside the shrink-rings being 47 in. and 57½ in. respectively. The fly-wheel is afterwards pressed into its position on the largest part of the shaft. On the inner side of the fly-wheel the hub is extended by a flange, which projects over the hub of the spider, and is bolted against machined faces on the spider arms by eight 2½-in. diameter tightly fitted bolts.

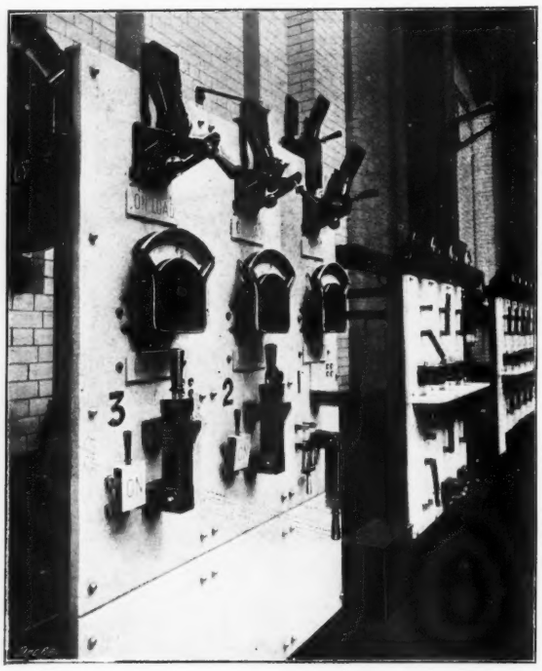
The armature core is built up of steel laminæ between



Musgrave-Westinghouse 2,000-kw. Generating Set.

cast-steel end-plates. The core and spider are traversed by air passages so that when the machine is running, a cooling stream of air circulates through the core and round the windings.

The armature conductors are of copper bar, forged to shape and insulated before being placed in the slots; they are simply laid in position without any forcing, bending or hammering being necessary, and secured by hard fibre wedges driven lengthwise into notches in the slots above the conductors.



Generator Switchboard, Nos. 1 to 3.

An important feature is the provision which has been made in the armature winding to secure sparkless commutation and cool running. Certain points in the armature windings, which are normally at equal potentials, are connected together by additional conductors, so that any difference of potential between the points so connected and produced by want of magnetic balance is followed by a flow in one direction or the other in the additional conductors. These currents are alternating in character and interact on the field-magnets, either demagnetising or magnetising them to the necessary state of balance. The currents, therefore, which are occasioned by the want of magnetic balance, do not pass by way of the brushes and sparkless running is secured. Another important effect is that should the armature be out of centre in the field the heavy magnetic pull of the armature on the side nearest the poles is prevented.

The steady sparkless running of the generators at the Bankside Works is particularly noticeable, and speaks well for the efficiency of the Westinghouse method of balancing the magnetic circuits.

The commutator is constructed of hard drawn copper segments insulated by mica sheets. Carbon brushes are used, tightly secured in spring brush-holders. The brush-holders are arranged in sets of eight, carried on rigid brackets, supported in turn from a continuous ring which is concentric with the field ring. The brush or rocker ring is held by brackets close to the field ring, thus leaving the outer end of the commutator free and open for attention or cleaning. The lead of the brushes is adjusted, for all simultaneously, by a hand-wheel which connects through rods and bevel gearing to the brush ring.

The finished armature of the machine is some 12 ft. in diameter, and 3 ft. deep; the commutator being about 10 ft. in diameter by 22 in. wide at the collecting face. The total approximate weight of the complete armature and commutator is 85,000 lbs.

Throughout these works we find that every effort has been made to secure simplicity in design and freedom from all unnecessary complications. For this reason the generators are shunt-wound and not compound, and the switchboard arrangements have been reduced to the simplest possible form.

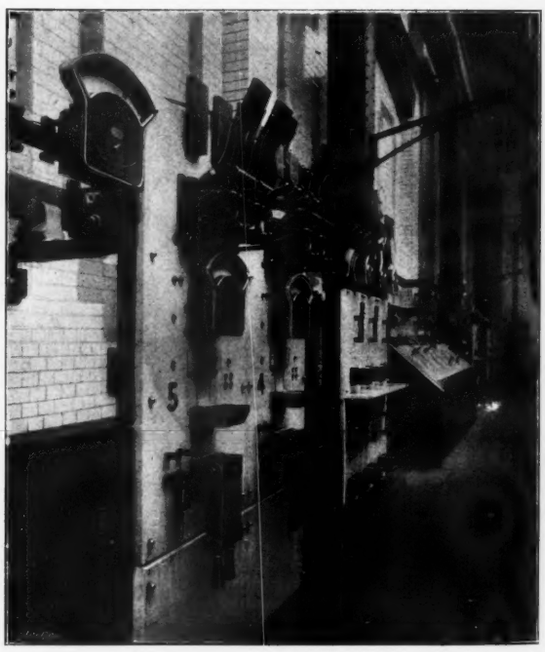
The switching gear is carried on a gallery running from end to end of the station, and consists of a long row of panels, each having separate connections to the main station bus bars, which are formed of 6 in. $\times \frac{1}{4}$ in. copper strips mounted on special forked porcelain insulators, supported on angle iron brackets.

The panels are built up of marble slabs supported on angle iron frames, fixed to the gallery floor about 4 ft. away from the wall, to which they are tied by light angle iron stays. All connections are made at the back of the boards, the cables rising vertically from beneath; parallel copper connectors are carried across, forming connections to the main bus bars.

The generator panels and regulating boards are isolated from the rest, and occupy the centre position on the gallery, the circuit panels ranging along the entire length of the gallery on either side. The generator switchboards are of the usual Westinghouse type, provided with illuminated-dial Weston instruments and an additional polarised central zero voltmeter, fixed on a swing bracket, which enables the instrument to be observed from any position, and therefore greatly facilitates the paralleling of the machines.

Each generator is protected by Westinghouse automatic circuit breakers on both poles of the machine, the tripping gear being so arranged that it may readily be operated by hand, thus providing a switch for taking the generators out of circuit.

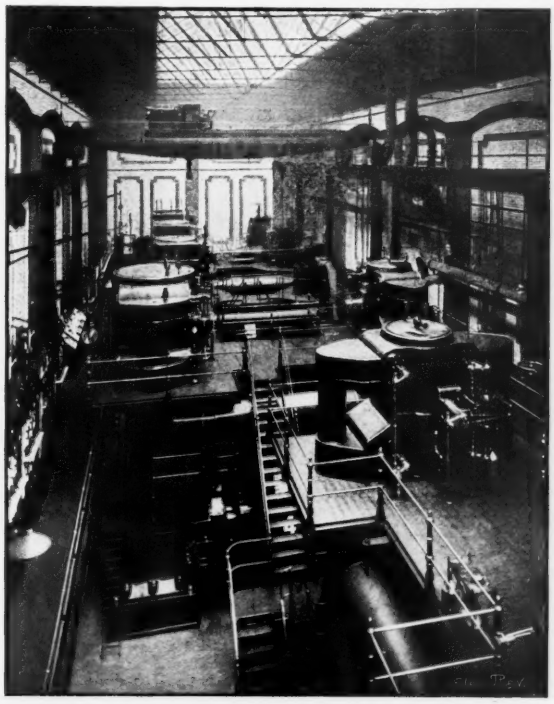
A single-pole lever switch is also fixed to the positive pole immediately below the ammeters, for use when closing machines up on circuit.



Generator Switchboard, Nos. 4 and 5.

The circuit breaker on the negative pole is actuated by excessive load only, an adjustment being provided whereby it may be set to operate at any desired maximum load. That connected to the positive pole and located immediately over the switchboard panel is actuated by excessive or return current load, by a tripping device consisting of a small suspended coil fixed between the yokes of an electro-magnet, clamped to a vertical connecting bar between the lever switch and circuit breaker. The main current from the generator magnetises the yoke pieces and causes the sus-

pended coil (through which a small shunt current from across the machine terminals is passed) to be deflected on either side of zero, according to the direction and magnitude of the current passing. The movable coil carries a small metallic tongue, which is capable of adjustment; this is made to close the circuit of an auxiliary shunt relay, which in turn releases the trip gear.



Bird's-Eye View of Station.

One of the most interesting features of the electrical equipment is the special attention which has been given to the distributing feeder switchboard.

There is probably no place in the world where so much excavating is carried out as in the streets within the City area. The congested state of the numerous pipes which form the foundation of the City roadways, the mad haste of all the companies concerned to grab the last few remaining inches of soil, combined with the reckless carelessness and wanton indifference displayed by the men in charge of wedge and hammer, produce a risk to electrical mains which few can appreciate who have not suffered from it.

The City Company, recognising the enormous risks to which their mains are thereby subjected, determined to provide every precaution possible to minimise the disastrous results which would otherwise attend mechanical damage to their extensive distributing system.

After careful investigation of the general practice at other stations, it was found necessary to carry out an exhaustive series of trials of circuit breakers and fuses. The difficulty of controlling heavy currents at 500 volts was soon demonstrated, but success was attained by the combination of a quick break, wide gap switch, and a special form of 500-volt fuse holder, invented by one of the staff.

On trial this combination was found to meet the lighting requirements somewhat better than automatic cut-outs, which are too readily operated by minor disturbances, and it was decided to protect each feeder, both at the generating station and the distributing centres, by such an arrangement.

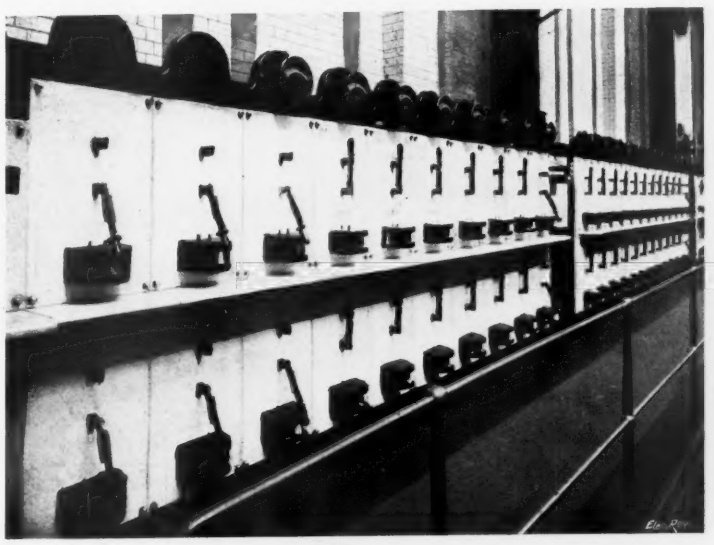
The distributing feeders (of which there are about 40) consist of double concentric ·5 sq. in. paper-insulated lead-sheathed cables of the British Insulated Wire Company's manufacture, and are brought up and connected to the back of the main station panels, while the middle wire connection to the City, which consists of three 1 sq. in. cables, is brought to a separate middle wire board on the north side of the station, to which the rotary balancers at Bankside and the recording leakage indicator in the earth connection are coupled.

The feeder switchboards consist of vertical marble panels, each having a Weston ammeter of the shunt type at the top. These instruments are provided with specially constructed catches, which hold the needles after they pass a certain maximum reading, thus affording a ready means of locating any momentary disturbance which may occur on the distributing networks. A projecting marble shelf half way down the panel forms a division between the poles of the circuit. A B.T.H. quick-break switch, and a Peard patent fuse are mounted on these panels, and connected to each pole of the circuit.

These fuses, which the City Company have been the first to adopt, are of novel but exceedingly simple construction, the principle on which they work being to reduce to a minimum the duration of the arc, by mechanical means, and to screen the connecting terminals from the metallic vapours formed.

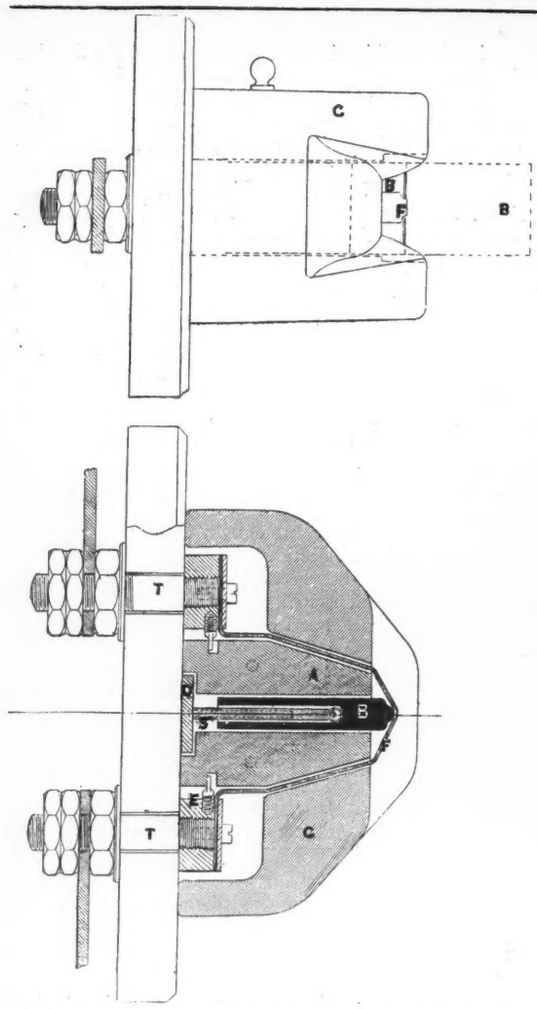
The device consists of a bridge or central block of non-conducting material interposed between the terminals to which the fuse is fastened. This central bridge contains a movable screen, which is pressed continuously outwards against the fuse at its weakest point. The connecting terminals are protected from metallic vapour formed by the volatilisation of the fuse, by means of a cover which is fitted round the central block, the fusible connection being exposed only at the point where it passes over the movable screen.

When in operation the movable screen is instantly interposed between the two parts of the fuse at the moment when fusion commences. The rapidity with which the screen works, and the very small quantity of metal actually fused, effectually prevent the formation of a destructive arc, and the arc formed at the moment of breaking circuit is entirely confined to the replaceable fuse at its point of severance.



Feeder Switchboard (Southern Portion).

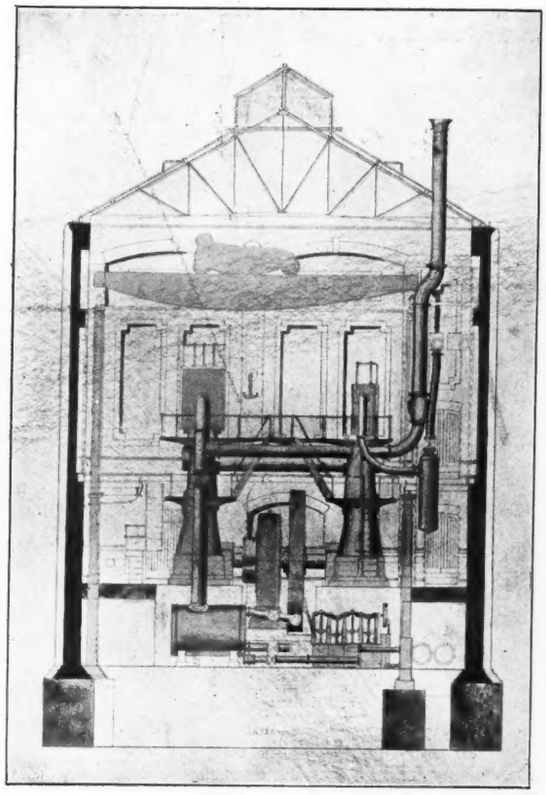
At present the City Company have transformed eight of



A, Centre block; B, Movable bridge (the dotted outline shows position when fuse has blown); C, Outer cover; D, Bridge catch; E, Pins fixing centre block F, Fuse; S, Spring; T, Terminals.

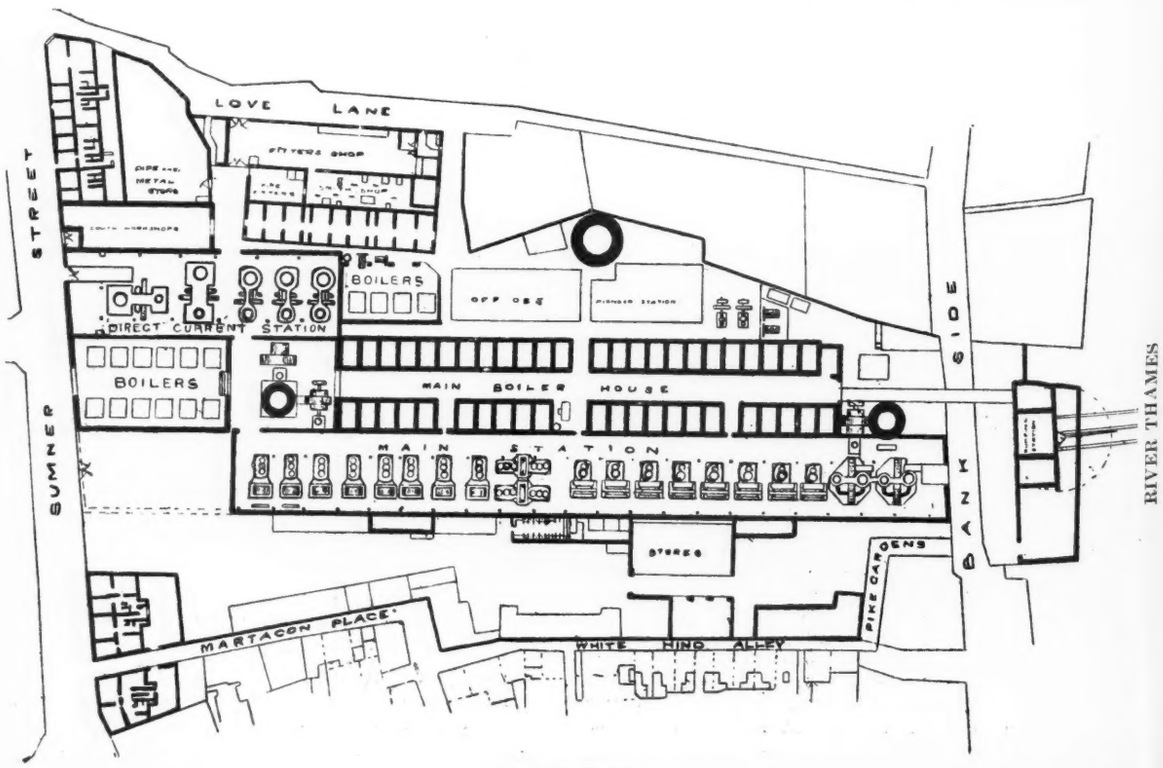
End Elevation and Section of "Peard" Fuse.

their sub-stations to direct current supply. These stations are fed from the generating station by a number of ·5 sq. in. D.C. mains, laid in wrought-iron pipes.



Cross-Section of Direct Current Station.

The middle wire connection forms a common link between the various sub-stations, and is directly connected to the Bankside and City rotary balancers by the special 1 sq. in.



Plan of Works

mains above-mentioned. The feeders from the generating station are connected to the distributing bus bars through fuses at the sub-station end. The low pressure network, which is on the 3-wire triple-concentric system, is fed by a number of triple-concentric distributing feeders, which are also provided on each pole with switches and fuses of a type similar to those used at the generating station.

Each of these distributing feeders supplies a separate section of the low pressure network, having approximately equal lamp connections. The network is provided with junction boxes at the corner of each street, thus enabling the sections to be readjusted whenever required for the purpose of equalising the pressure.

In the case of damage to feeders, this arrangement also enables any section to be supplied from the adjoining sections, thus greatly reducing the inconvenience which would otherwise occur with a more rigid system, while at the same time introducing the maximum factor of safety.

For lighting purposes the 200 volts supply only is taken into the premises of the consumer, and in each case the middle wire conductor is connected solid, a cut-out being provided on the outer pole.

All consumers' fittings are of a type tested and approved by the City Company, the latter having undertaken and made an extensive trial of all descriptions of fittings.

A large portion of the supply to the City is now given from the direct current plant. It is estimated that this plant will suffice for the requirements of the City for an indefinite period during the summer months, and also during hours of light load throughout the year, and as it can be operated without any losses of transformation, the supply being direct from the generator to the consumer, it is clear that considerable economy must result; the problem of securing the assistance of the alternating current plant is easily met by the proposal of the company to use motor-generators during the heavy loads for about three months in the year. These motor-generators, some of which are now on order, are being constructed for use primarily with the alternating current side as the motor, and as they will be placed at the various distributing centres they will generate continuous current at the point where it is required, and thus augment the direct supply of continuous current from the main steam generators. In the meantime, until this work is carried out, the motor-generators are being placed at the works, and will be used in the reverse manner by driving the continuous current machine as a motor, and thus generating alternating current during hours of light load, and enabling only one set of steam plant to supply the requirements of the whole district.

A remarkable result has been obtained from this plant during the past year, for although the output sold was slightly in excess of that recorded in the previous year under exceptional circumstances, the coal consumption shows a decrease of no less than 23,000 tons!

In conclusion, as we have already indicated, we are indebted for these particulars, and for permission to photograph the plant, to Mr. Frank Bailey, engineer-in-chief to the City of London Company, and for their kind assistance to Mr. F. H. Jackson, Mr. Rycroft, Mr. D. Wilson (superintendent of the works), and Mr. O. L. Peard.

ELECTRICAL MOTOR-CARS AT THE CRYSTAL PALACE.

Saturday last saw the close of the Crystal Palace and Motor Traders' Co-operative Exhibition at the Crystal Palace. From the point of view of the number of exhibitors the show cannot, by any means, be considered to have been a success, but considerable interest was shown in the vehicles on view, comprising as they did the productions of such well-known makers as Panhard, De Dion and Napier. The display of electric vehicles was confined to three concerns—Messrs. Haycraft & Sons, Limited, the Broadway, Deptford, the Imprimis Motor Car Company, 78, Queen Victoria Street, E.C., and the British Electromobile Company, Limited (late the British and Foreign Electric Vehicle Company, Limited) of 4, Bloomsbury Place, W.C., the exhibit of the last-named concern being the most important.

The two vehicles shown by Messrs. Haycraft call for no special remark at this time, they being on the Mackenzie-Riker system. The frames of the cars are of tubular construction. A single electric motor is used, this being carried forward of the rear axle and connected to it by spur gearing. The battery comprises a set of 40 accumulators, the capacity of which is stated to be sufficient for a run of 40 miles on one charge. The controller is adapted to give three forward and three reverse motions.

Delivery vans appear to be the speciality of the Imprimis Company, who had on view two vehicles of this type. They are of German design and build, being constructed at the works of Herr Heinrich Scheele, of Cologne. The larger of the two vans shown is intended for a large laundry in Sussex, and is designed to carry loads of from 1 to 1½ tons. Two electric motors are employed, these being supported behind the rear axle, the power being transmitted by pinions on the motor shafts to large spur wheels bolted to the hubs of the rear-road wheels. No information was available as to the type and number of accumulators forming the battery of this car. It is carried in a chest supported by springs from the frame, below the floor-boards of the van. The driver has three speeds forward, and two reverse at his command; the steering is actuated by a horizontal hand wheel, while ample brake power is provided.

In the light delivery van a different arrangement is adopted. It is intended to carry a load of 1,500 lbs. in addition to the driver and attendant. A single electric motor is used in this car; it is arranged at about the centre of the frame, and drives a differential countershaft by spur gear wheels, special duplicate chain gearing conveying the power to the rear-road wheels. The battery consists of 40 accumulators, have a capacity sufficient to run the vehicle from 35 to 40 miles on one charge. As in the large van, the cells are carried in a box which is supported by springs to overcome any vibration set up when travelling over rough roads. The controller is adapted to give three forward speeds, ranging up to 12 miles per hour, and two reverse motions. Both volt and amperemeters are fitted in the dashboard in front of the driver, while special attention has been paid to the question of brakes.

The new vehicles of the British Electromobile Company, Limited, are extremely interesting, and comprise several new features, as a result of the experience gained with the "Powerful" car, whose exploits in the way of long runs last year have been referred to in these columns. Of the new type two cars were shown, one a four-seated *dos-à-dos* and the other a double phaeton with the rear seat slightly raised. The frames are of channel steel construction. Two electric motors are employed to drive the car, these being spring-suspended on the fixed rear axle, one at each end, pinions on the motor spindles meshing with large spur wheels connected to each of the rear road wheels, the power of the motors being thus conveyed to the wheels by a single reduction. To the top of the motors, E (fig. 1), spiral springs, A, are fixed, these springs bearing on the brackets, B, and so taking up any thrust of the motors. The spur gearing is entirely enclosed in dust-proof oil-containing cases, T.

Passing now to the accumulators, the British Electromobile Company, after many experiments, have adopted the Leitner, the battery consisting of 42 cells placed in compartments in the body of the car. These receptacles are provided with hinged tops, so that the cells can be quickly inspected or removed. The battery, which is adapted to be charged from mains giving a pressure of 110 volts and upwards, has a capacity, in the 8-H.P. car, sufficient for a run of 60 miles at an average speed of 12 miles per hour, on one charge. Mr. Chambers, of this company, has gone very thoroughly into the question of the recharging of automobile batteries. Not only has his company prepared a list of places throughout the United Kingdom where they may be recharged, but for clients in the London district, they have arranged to enter into contracts to recharge as often as desired, and maintain accumulators at an inclusive rate per year.

An interesting detail of the new cars is the controller C, which is now quite separate from the steering pillar, and set at a slight angle, so as to be within convenient reach of the driver. It consists of a revolving cylinder, enclosed in a

RIVER THAMES

water-tight aluminium case, the cylinder carrying a number of contact blocks, on which press a row of stationary contact fingers. As the handle of the controller is turned, various electrical combinations are produced, with the following eight effects:—

R. Reverse speed.	2. Second speed forward.
B. Electric brake.	3. Third ,,
S. Stop.	4. Fourth ,,
1. First speed forward.	5. Fifth ,,

Each position of the handle is at an angle of 45° with the next, and a simple mechanism renders it impossible to make an imperfect contact by leaving the handle in an intermediate position. The controller is adapted to be operated by the left hand of the driver, thus leaving the right hand free to control the inclined steering wheel. The connections for the recuperation of the battery are entirely outside the main controller, and are obtained by means of two pedals.

The vehicles are each equipped with three brakes—the emergency electric brake applied through the controller, the medium electric brake due to recuperation, and pedal-operated band brakes on drums on the hubs of the rear road wheels. These latter brakes act equally well, be the car travelling in a forward or backward direction, and when put in action the electrical circuit is automatically broken.

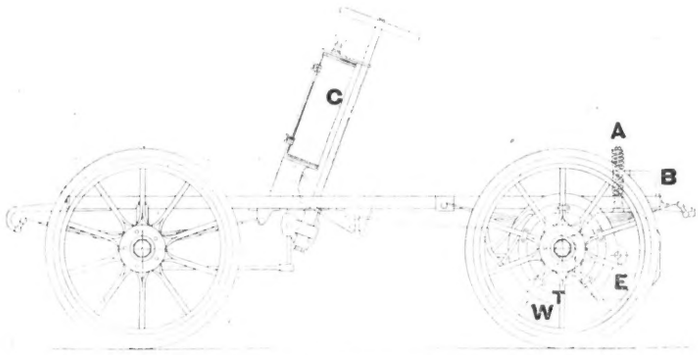


Fig. 1.—Frame of Car.

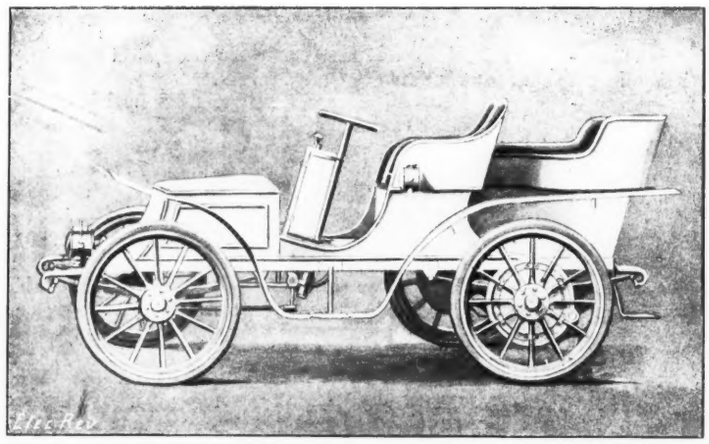


Fig. 2.—Complete Electric Tonneau of the British Electromobile Company.

The road wheels are of the artillery type, and are usually shod with solid rubber tires, the company finding these more reliable than pneumatics, which, however, they will fit if desired. Altogether the new vehicles mark a step forward in electrical carriage design, the bodies of light construction reminding one very much of those found on modern petrol motor-cars. The company had also an electric brougham of the Lohner-Porsche type on view, the feature of this car being that the electric motors are located inside the front road wheels, the armatures being fastened to the hubs and the stationary fields to the axle.

REVIEWS.

The Engineering Index, 1896—1900. Edited by H. H. Supplee, B.Sc. London and New York: The *Engineering Magazine*, 1901.

This weighty volume is a re-edition of the very excellent index of engineering literature which appears monthly in the *Engineering Magazine*. We do not know to what extent, if at all, the original index has been cut down. Probably the editor, than whom few are better fitted to carry out such a work as this, has exercised his judgment in deleting references to subjects which, though at the time they may have contained promise of success, have since disappeared from the realm of practical everyday problems. Suffice it to say that the five years' index as it now appears is a very good production. By its aid a full list of many of the more important articles on any given subject may be got out, and the original article obtained in the back numbers or referred to in some library. Such an index is invaluable to the man who wishes to know what has been done in any special subject in which he may be interested.

As a few samples of the book, we find no fewer than 20 articles indexed on mechanical draught. There are 45 references to the use of blast-furnace gas for power purposes, and nearly 60 on liquid air.

Under water-tube boilers, we see no reference to the Belleville boiler, by which we conclude that the editor considers it unworthy of further consideration. Again, there are 16 pages with references to electric tramways and allied subjects. We can cordially recommend the volume to the student of any subject of engineering practice. If anything worth reading on it has been written, it will probably have been tabulated in this excellent index.

High-Speed Engines. By W. Norris and Ben Morgan. 2nd edition. London: P. S. King & Son. 1902.

This second edition appears to be the first edition with additional sections descriptive of the high-speed engines at Paris, 1900, and Glasgow, 1902. These are well represented, though we hardly think the Borsig engine of 2,500 H.P. comes strictly within the scope of the title.

A peculiar engine is the Mertz, a double piston engine with cylinders placed tandem fashion having oppositely-moving pistons with one tubular piston rod and two cranks for the outer piston rod. A nearly perfect balance is, therefore, attained, especially as regards rocking on the longitudinal axis of the engine. We are pleased also to find the Sisson engine described and illustrated. In this engine a small rocking moment is secured by placing the high and low cylinders nearer together than their joint radius by raising the high-pressure cylinder sufficiently high to permit the low-pressure cylinder cover to be removed. The two lines of parts are made to balance, the valves are of piston type with air buffer, there is splash lubrication with self-adjusting ends to the connecting rod, and, finally, there is a large and light door, perfectly oil tight and instantly movable, affording easy access to the interior.

The governor is very powerful, and from no load to full load and *vice versâ* suddenly applied, less than 2 per cent. variation of speed momentarily resulted for 600 amperes on an engine 11 in. and 20 in. × 11 in. at 350 r.p.m. For 1,100 amperes the variation was less than 3 per cent. In every case the settled change was only 5 revolutions.

There must be some 50 or 60 engines herein described,

and by far the greater number are English. One marvels where they can all be used, and where the market is found for so many.

The book gives an excellent idea of the form and principle of most of those it describes, and the illustrations are good —many of them being very specially good. Anyone who wishes to find in condensed form the present status of the high speed engine should secure this book.

NOTES.

(*Continued from page* 342.)

Institution of Electrical Engineers (Glasgow Local Section).—The first annual dinner of this branch of the Institution was held at the Windsor Hotel, Glasgow, on Tuesday, February 18th, under the chairmanship of Prof. Magnus Maclean, the croupiers being Mr. Henry A. Mavor, vice-chairman of the Section, and Mr. W. A. Chamen, electrical engineer to the Glasgow Corporation. Covers were laid for a little over 100 guests, and among those who sat down were the Lord Provost of Glasgow, Prof. Archibald Barr, President of the Royal Philosophical Society, and Bailie Maclay, convener of the Glasgow Corporation Electricity Committee.

Bailie W. Maclay, convener of the Glasgow Corporation Electricity Committee, proposed the toast of "The Imperial Forces," and this was replied to by Colonel Archibald Denny. Mr. H. A. Mavor proposed "The Lord Provost and Corporation of Glasgow." He said that their Corporation had, above all, recognised electrical engineering as a force and factor in the development of their civilisation. They had swept from the streets the dirty old tramcars with their mules and horses, and they had given them in their stead what might be described as fairy illuminated palaces, flying along at any speed up to 30 miles an hour. They had recognised the electrical engineer to the extent of spending three millions of money in acquiring his products. He could remember when there were only three electrical engineers in Glasgow; now there was one on the front of every tramcar! He would remind them, however, that the electrical industry was only just beginning in Glasgow, and in that connection he would like to bring one point to the notice of the Corporation. They must not sit down satisfied thinking that they were supplying electrical energy as cheaply as it was done elsewhere. It was a hobby of his that if the Glasgow Corporation would supply the energy for lighting and traction as a complete scheme instead of under two separate departments as at present, the price of electrical energy could be greatly reduced. It was not fair that the user of power should be forced to take his supply from the dearest station.

The Lord Provost replied in suitable terms, and in the course of his speech he said that he rejoiced to think that in the various departments of the Corporation in which they used electric energy they had achieved no inconsiderable success. He looked forward to greater success in the future, and he invited the hearty collaboration of all electrical engineers in developing this force, and so make the city of Glasgow a centre from which should go forth all over the country the products of their genius and their success.

Prof. Archibald Barr proposed the "Institution of Electrical Engineers."

Mr. R. Kaye Gray, of the parent section of the Institution of Electrical Engineers, in the absence of Mr. W. E. Langdon, President, and Mr. W. G. McMillan, secretary of the I.E.E., London, replied to the toast by Prof. Barr, and also proposed the toast of "The Glasgow Local Section."

Prof. Magnus Maclean replied on behalf of the local section.

During the evening an interesting programme of songs and recitations was gone through.

Sulphuric Acid.—Messrs. F. W. Berk & Co., Limited, of 1, Fenchurch Avenue, E.C., are supplying a specially prepared diluted sulphuric acid for use in accumulators. It is made from best Sicilian brimstone and distilled water, and is claimed to be specially pure for this purpose.

Professional Etiquette.—The extracts which we reproduce below are from a printed form issued by two municipal authorities which recently jointly advertised for electrical engineers.

"In preparing applications, engineers are requested to include for the following work:—

"1. To advise as to the possibility of the B.O.T. sanctioning the erection and equipment of a joint generating station for both districts, seeing that each Council has obtained a separate provisional order, and that in neither of such orders is there a power of transfer; also, if the consent of the B.O.T. can be obtained, what decided advantage would be derived therefrom?

"2. The preparation of the requisite plans, specifications, estimates, and particulars for obtaining the necessary borrowing powers, the consents of the B.O.T. or other authorities, and the conducting of such necessary negotiations, &c., in connection therewith, as are usually conducted by engineers.

"3. The designing of the generating station, and the electrical equipment of both the electric lighting and the tramway system; also the superintendence thereof.

"4. The preparation of the necessary working drawings, surveys, and detail plans, and the superintendence of the construction of the tramway track, including the bonding, paving, and making good.

"The Councils will be glad to have the terms set forth under the following heads:—

"(*a*) For preparation of plans, specifications, estimates, &c., as per Clauses 1, 2, and 3.

"(*b*) For the preparation of detailed plans, and the superintendence of the construction of the permanent way, as per Clause 4.

"Please state also what allowance would be made from your terms:—

"(*c*) In the event of an architect being employed by the Council to design and superintend the erection of building for generating station (exclusive of electrical equipment).

"(*d*) In the event of the construction of the permanent way, including laying of rails, paving, and bonding being done by the Council's men, or contractors, under the superintendence of their respective surveyors, or other officers whom the Council might appoint for that purpose.

"Applicants are requested to state their previous experience and qualifications in regard to both electric lighting and tramway work, together with any other details which they may consider likely to further their application, and to set forth therein the duties they would undertake to perform for the fees or commission required by them.

"Applications should be delivered to the undersigned, sealed and endorsed on cover 'Tramway and Electrical Engineer,' on or before," &c.

In filling up this extraordinary form, the engineer is to assess the value of his services in various capacities, and to schedule his respective prices and deductions, as though he were a contractor offering himself for sale, or a butcher preparing a carcase for market! Competition is a good thing, no doubt; but who in the world would dream of advertising for a solicitor or a consulting physician? self-respecting consulting engineer, with the slightest regard for professional etiquette, could be expected to reply to such an invitation. Our chief regret is that the past conduct of certain "professional gentlemen" should have been such as to render this condition of affairs possible.

Mr. Duddell at the Royal Institution.—The Friday evening discourse at the Royal Institution last week was given by Mr. W. Duddell, whose subject was "Musical and Talking Electric Arcs." The Duke of Northumberland was in the chair, and among those present were Lord Kelvin and Lord Rayleigh. The *Times* report states that in dealing first with talking arcs, the lecturer showed how the vapour column of the arc varied in size with variations in the current which produced it, and was sensitive to both very small and very frequent variations. Hence when the current from an ordinary microphone transmitter was added to the current maintaining the arc, the vapour column of the latter changed its size in correspondence with the changes in the telephonic current, minute though they were, and set up sound waves in the surrounding air, which gave reproductions of the sounds spoken into the transmitter. Thus the arc acted as a receiver, and, as the lecturer demonstrated to the audience, reproduced sounds spoken into the transmitter of a telephone in a distant part of the building. Moreover, the light given by the arc varied under the influence of such a telephonic current, and this fact could also be used to transmit sounds. The light of the arc was made to fall upon a selenium cell, which was included in another telephonic circuit. Selenium being a substance the electrical conductivity of which varied with the intensity of the light energy to which it was exposed, the variations in the light of the arc, though imperceptible to the eye, produced variations in the current passing through the second telephone, which thus repeated the sounds spoken into the first telephone, though there was nothing to connect the two except the beam of light proceeding from the arc. A permanent record of the sounds could be obtained, as Runge suggested, by passing a sensitive film through the beam of the talking arc, and then, having developed it, drawing it over a selenium cell with a strong light behind it; a telephone connected with the cell would then reproduce the original sounds. In the second part of the lecture Mr. Duddell showed how an alternating current could be derived from any direct-current arc, without the use of an alternator, simply by connecting a self-inductive circuit containing a condenser as a shunt round the arc. The only precautions to be observed were that the resistance of this circuit must be kept below a certain limit and that solid carbons must be used in the arc. In these circumstances the arc gave a musical note, the pitch of which depended on the frequency of the alternating current in the shunt circuit. This frequency could be altered either by varying the capacity of the condenser or the self-induction, and the variations required to get a given note were a matter of mathematical calculation. Mr. Duddell showed a small keyboard which in this way was made to give two complete octaves of the musical scale. He pointed out that the alternating current obtained in this simple manner from a direct current could be used to exhibit all the phenomena of high-frequency currents, and among other experiments he employed it, after transforming it up twice by ordinary methods, to give the Tesla discharge.

Society of Engineers.—On March 3rd a paper will be read by Mr. B. H. Thwaite, C.E., on "British *v.* American Patent Law Practice and Engineering Invention."

Long Automobile Run.—An American journal, *Science and Industry*, reports that at Chicago an automobile has run a distance of 187½ miles on one charge of its storage batteries. We are not told the weight of the vehicle or of the batteries, but are thankful for the odd half-mile and for the truthfulness that would not allow the run to be rounded up to 188 miles. Accuracy in such statements is always welcome.

Electric Omnibus.—It is announced that Messrs. C. A. Zadig & Co. have entered into an arrangement with the London Road Car Company, Limited, to introduce an electric omnibus to carry 26 passengers. It is expected to be ready in three or four months.

Correction.—In our last issue in our "Official Notices," a printer's error made us say that the salary offered by the Cape Town Corporation for an electrical engineer was £350 per annum. This should, of course, read £650, as we stated in our "Notes," page 308.

Scottish Electrical Contractors' Association.—The second annual general meeting was held at the secretary's office, 168, St. Vincent Street, Glasgow, on Monday evening, February 24th. The chairman, Mr. Wright, reviewed the work of the General Committee for the past year. He stated that the rules for workmen had been accepted by the men's union for one year. The Committee had had a meeting with representatives of the manufacturers, and a further meeting was to be held shortly. The Association is in a very satisfactory condition, and good is already being done. The following are the committee and office bearers for the ensuing year, viz.:—President, Mr. Thos. Wright; vice-president, Mr. Wm. McWhirter; secretary and treasurer, Mr. J. M. Davies, jun., C.A.; members of Committee, Messrs. Munro, McAlpine, Chalmers, King, Richardson, McAulay, Martin, and Espie.

Electric Motors for Post Office Work.—It is reported in Liverpool that electric motor vans are to be substituted for the horse vans which have been used for some time past for a night postal service between Liverpool and Manchester. The Government, it is said, have entered into a contract with Messrs. G. F. Milnes & Co., of Hadley, Shropshire, for a supply of electric motor vans for such postal work. The dimensions of the cars are given as 16 ft. 11 in. long and 6 ft. 3½ in. wide, with a wheel gauge from centre to centre of the wheel tire of 5 ft. 1½ in. The cars will, it is said, be able to carry a load of 1 ton.

Progress at Bristol.—On Wednesday last week the new electricity works of the Bristol Corporation at Avonbank were formally inaugurated. The present instalment of plant comprises four Babcock boilers, two 745-KW. Willans-Siemens steam alternators, and two 165-KW. steam dynamos, the latter being intended to supply power for use in the works. Condensing plant has been provided by Messrs. W. H. Allen, Son & Co, and the switch-gear is of the Ferranti type. Three trunk mains to Temple Back station have been laid by Messrs. Siemens Bros. The scheme for extensions, which provides for almost indefinite expansion in the future, was drawn up by the city electrical engineer, Mr. H. Faraday Proctor.

Appointments Vacant.—A working engineer is wanted for the Islington new infirmary; clerk of works in the Lancaster Tramways department; assistant engineer for the Whitby electricity department (£100).

Rubber Gloves.—Referring to a note in our last issue, we understand that the Silvertown Company have made a practice of testing their rubber gloves up to 5,000 volts for the last two years, the pressure being derived from a transformer.

THE CENTRAL STATION ENGINEER.

AN arrangement has been arrived at between the Electricity and Tramways Committees of the Southampton Corporation, whereby Mr. H. F. STREET is appointed tramways engineer, having entire charge of the motors and electrical equipment of the cars as well as the overhead work. The Tramways Committee will pay £150 to the Electricity Committee for his services. Mr. GEO. SIMPSON, as traffic manager, will have complete control and management of the traffic of both horse and electric cars.

Mr. W. H. BIRD has been appointed to the post of improver at the Walsall Electricity Works.

The Town Council of Bridlington has appointed Mr. LOMAS electrical engineer to the Corporation.

The T.C. of Wrexham has raised the salary of the electrical engineer, Mr. W. SILLERY, from £150 to £175.

The Epsom U.D.C. are considering the appointment of a resident engineer on the near completion of their electrical works. Mr. FOSTER, who has been clerk of the works, is being considered in this regard.

On Wednesday, the 19th inst., at the Wallasey electric station, Mr. J. STARKEY, shift engineer, was presented with a handsome ornamental clock, suitably engraved, it being a wedding present given by the members of the staff of the gas, water and electricity departments; and Mr. P. S. THOMPSON, mains engineer, who has been appointed as assistant mains engineer at Manchester, was presented with a portmanteau and dressing case, as a token of the respect and esteem in which he was held by the members of the staff. Mr. Starkey has been appointed to the post vacated by Mr. Thompson.

Mr. A. E. WILSON, the assistant electrical engineer on the Southend tramways scheme, having resigned, it was decided to engage an engineer to fill his place at a salary of £130 per annum, rising by annual increments of £10 to £200 per annum.

Mr. CHARLES FURNESS, who was borough electrical engineer at Devonport, has been appointed to a similar position at Blackpool, at a salary of £520 per annum.

NEW COMPANIES REGISTERED.

Kent Electric Power Syndicate, Limited (72,742).—This company was registered on February 11th, with a capital of £10,030 in 100 ordinary shares of £100 each, and 600 deferred shares of 1s. each, to carry on the business of an electric power supply company in all its branches in the County of Kent and elsewhere, to adopt an agreement with T. N. A. Grove, and to act as electricians, metallurgical and mechanical engineers, &c. The first seven subscribers are:—Lord Avebury, 1 ordinary and 2 deferred shares; E. Sisterton, 26, Side, Newcastle-on-Tyne, 3 ordinary and 6 deferred shares; D. Fox, Marlborough House, Dewsbury, J.P., 1 ordinary and 2 deferred shares; B. L. A. Crosbie, 53, Victoria Street, S.W., consulting engineer, 40 deferred shares; F. A. Styant, 22, High Street, Cheltenham, solicitor, 40 deferred shares; N. P. W. Brady, 7, St. Helen's Place, E.C., solicitor, 4 ordinary and 48 deferred shares; and F. Faithfull Begg, Bartholomew House, Bartholomew Lane, E.C., stockbroker, 1 ordinary share. No initial public issue. The number of directors is not to be less than three nor more than 11; the subscribers are to appoint the first; qualification, 1 ordinary or 50 deferred shares. Registered office, 7, St. Helen's Place, E.C.

Greville Electric Inventions, Limited (72,837).—This company was registered on February 19th, with a capital of £25,000 in £1 shares, to acquire the British patents in respect of the electrical inventions of A. E. Greville, as specified in an agreement with the said vendor, to acquire the business carried on at 46, Farringdon Street, E.C., as "The Greville Engineering Works," and at 4, Holborn Bars, E.C., as "The Greville Electric Inventions," and to carry on the business of electricians, marine and mechanical engineers, suppliers of electricity, cycle and motor car manufacturers, &c. The first subscribers (each with one share) are:—A. E. Greville, Silverthorne, Willesden Lane, N.W., solicitor; H. E. Greville, 23, Rutland Park, Willesden Green, N.W., solicitor; Mrs. J. Greville, Silverthorne, Willesden Lane, N.W.; Miss. G. A. Greville, 23, Rutland Park, Willesden Green, N.W.; W. A. Greville, Silverthorne, Willesden Green, N.W., electrical engineer; H. J. Gartick, 70, Balderton Buildings, Grosvenor Square, W., clerk; and Miss C. A. Greville, Silverthorne, Willesden Green. No initial public issue. The number of directors is not to be less than two nor more than five; the first are A. E. Greville and W. A. Greville; qualification (except first directors), £200; remuneration as fixed by the company. Registered office, 4, Holborn Bars, E.C.

CITY NOTES.

Charing Cross and Strand Electricity Supply Corporation.

THE annual meeting of the shareholders of this company was held on Wednesday at the Savoy Hotel, Victoria Embankment, Mr. W. F. Fladgate presiding.

The CHAIRMAN, in proposing the adoption of the report, said he would first like to refer to the paragraph relating to the net earnings in the West-end. They were stated to have been £46,900, but that amount included £3,485 brought into the revenue account from the previous year, so that the actual net earnings had been £43,414. There were two or three matters in the report and accounts to which he would like to call the attention of the shareholders. It was a great pleasure to be able to say that their progress in the West-end districts still continued. The additional lamps which had been connected with the company during the past year amounted to no less than 27,906, and that was in a district in which there was competition in all parts. That satisfactory result showed that the company still possessed considerable vitality, and that there was still an increasing demand for electricity in the districts which they had served now for many years. St. Martin's, which was their old original district, had given them an increase of 10,159 lamps, which was exceedingly satisfactory. The Strand had given them an increase of 15,227, and St. Giles's and Holborn, which were comparatively small districts, had given them a fair increase. The great value, however, of those districts lay in the fact that they made the company's area self-contained, as without them there would be a considerable gap between the Strand and the City. The increase in the sales of light had amounted to 31 per cent. over the sales of 1900, which he thought was highly satisfactory. The supply of motive power was receiving the careful consideration of the directors, and they hoped that in the future that would be a source of increased benefit to the company. It had increased last year, for whereas in 1900 they were supplying horse-power to the extent of 927, in 1901 last year it had increased to 1,225; an increase of nearly 32 per cent., which was very satisfactory. That was only in the West-end district. Passing to the revenue account, he said they showed an elasticity and an increase which he thought was wholly satisfactory. The revenue had amounted to £99,715, as against £85,662 last year, or an increase of 16 per cent. He would like to call their special attention to the item for coals. It had more than once been pointed out that the consumption of coals by their company had not been quite as satisfactory as they could wish, and the year before last they had to contend with high prices and the difficulty of getting good coal. He was glad to say that this year there had been a considerable decrease in the price, and also owing to economies which had been devised and carried out by their engineer, the decrease in consumption had been very great, and alongside with that there had been a large increase in the light sold. In 1900 they sold 5 million units, in 1891 they sold 6½ million units. They would naturally have thought that that would have meant an increased coal con-

sumption, but actually there had been a decreased consumption of 459 tons, which meant a saving in money of £8,864. During the year no less than £6,894 had been spent out of revenue in keeping the plant and machinery in proper order, and in addition £9,000 had been carried to the depreciation account. After providing for the interest on debentures and loans, and the interest on the deferred shares, there was a satisfactory increase in the balance of profit, which stood at £32,165 as against £21,444 in 1900, being an increase of no less than 50 per cent. Under those circumstances he did not think they need hesitate in recommending a dividend of 10 per cent, which would leave £10,650 to be carried forward, being £7,000 more than they carried forward the previous year. As to the reserve accounts, they now amounted to no less than £90,000, and if they included the share premium account, they would amount to £157,000, which, he thought, was a sufficient sum for them to have as reserve accounts, and which were a source of very great stability to the company. The sum lent to the Charing Cross and City Company, £271,148, was an advance which they might consider as absolutely fully and satisfactorily secured, for the reason that it was being spent on plant, which, when put down, became the property of their company. He had great pleasure in congratulating the shareholders on the rate of the progress that had been made in the City. At the beginning of the year they were in connection with 3,427 lamps, at the end they found themselves connected with 51,836; which gave them a revenue of £9,614. They could not expect at the beginning of the business that they could start the revenue account of the undertaking without some slight loss, but only £766 had to be carried forward to the debit of that account. He thought they would agree that those results were very satisfactory. With regard to the works, the station at Bow was for all practical purposes complete, and there was still a very considerable space there which would enable them if necessary to double the capacity of that station. Machinery was there installed sufficient to supply 225,000 lamps. The trunk mains from that station to the city were laid, and were now in progress of being tested. He hoped it would not be long before they would be able to use those mains, and then they would be in a position to supply from their sub-stations 225,000 lamps through their distributing stations at Ludgate Hill, Cannon Street and Fenchurch Street. The mains which were to be laid in the City were already completed in 76 out of the 126 compulsory streets in their area, and in addition they had laid mains in 50 non-compulsory streets, so they might say that not only had they made a good beginning, but that they had made considerable progress with the work which had to be done there. They had done an enormous amount of work during the last year and a quarter. They did not get their Bill until the session of 1900, and since then no less than 114 miles of mains had been laid, against the 164 miles laid in their West-end districts during the past nine years. As showing the satisfactory progress which had been made in the City, he might tell them that it took nearly five years in the West-end to get the same number of lamps they were now supplying in the City. They had got sufficient area in all their three sub-stations to hold plant and machinery for a very much larger quantity of light than they were supplying at the present moment, and he did not think they would require more sub-stations, although they might want additional machinery. He was not given to prophesying, but he firmly believed that in the course of the current year they would be supplying no less than 150,000 lamps in the City, as fresh contracts were coming in daily. As to competition in the City, he had not the slightest hesitation in saying that there was ample room for both companies to supply at a fair price, but they must not expect to get the high price obtained by the City Company. In conclusion, the chairman gave figures showing the progress which the company had made during the last 10 years, and said that their future prospects were altogether good. Starting with a dividend of 5 per cent, they had now attained the 10 per cent. promised in the original prospectus, and they were thoroughly satisfied with the results of their expedition into the City.

Mr. John M. Gatti seconded the motion, and the report was adopted.

Westminster Electric Supply Corporation.

Lord Suffield, K.C.B., chairman, presided on Wednesday at the offices, Eccleston Place, over the ordinary general meeting of the shareholders of the Westminster Electric Supply Corporation.

In moving the adoption of the report and accounts for the past year, the Chairman said: I have much pleasure in stating that the business of the corporation continues to advance in a very satisfactory manner. The number of lamps, calculated in 8-c.p., added during the 12 months ending December 31st last, taking into account the public lighting, were 63,873, which, as stated in the report, is the largest number connected in any one year since the corporation commenced business. Unfortunately, two very considerable items in the revenue expenditure, over which your directors have no control, show a very large increase. I refer to rates and taxes and coal. Under the recent quinquennial valuation, the former account shows an increase for the year of no less a sum than £4,150. At our last ordinary general meeting it was stated that we hoped that there would be a considerable reduction in the price of coal, but I regret to say that that hope has not been fulfilled. On the contrary, the price of Welsh steam coal steadily rose, and it was not until July last that we were able to obtain more satisfactory prices. Until July we were forced to pay the highest price for coal that we have ever paid, but after that time, by taking every advantage of the market, and only making contracts for short periods, we were able, to a certain extent, to equalise prices. Even then there has been a net increase in our expenditure on coal of over £3,000. Proprietors will, no doubt, bear in mind that, working as the company does in the West-end of London, it is absolutely necessary that we should use only the best quality of steam coal to prevent smoke and other nuisance. Proprietors will understand that when we tell them we have been on several occasions fined, and, therefore, it is important that we should use the best coal. Taking these circumstances into consideration, I feel that your board can congratulate the shareholders of the company on the rate of dividend having been maintained. As you will have seen from the report, the public lighting of our district has advanced very satisfactorily, and, I think I may fairly say, that the lighting of that part of the city of Westminster which we have undertaken, compares very favourably with that of any other London district. We hope that the trunk mains that have been laid to connect the Westminster Company's stations with the Central Company's station at St. John's Wood will be carrying energy for the requirements of the ensuing winter. Meanwhile some of the high-tension plant which has been running already at Eccleston Place station, has done, and is doing, most important service in maintaining our supply. The recent issue of cumulative preference shares, with the exception of a very small surplus, was taken up by the shareholders. The board regret that there was so small a balance left that they were unable to allot any further shares to those proprietors who had applied for an extra number should there be any surplus. The extra applications exceeded 35,000 shares, whereas the whole issue was only 30,000. I do not think that there are any other matters to which I should refer, but we shall be pleased to answer any questions that may be asked. I therefore beg formally to move: "That the report and accounts for the past year be received and adopted."

Mr. Boulnois, M.P., seconded the motion.

Mr. Reed asked for further details with regard to the item for sundries. He noticed that it stood at the sum of £12,000, as compared with £5,000 in the previous accounts.

The Secretary said the items were made up as follows:—By depreciation of mains, £10,927 6s.; meters and instruments, £3 19s. 9d.; and plant, £1,201 9s. 3d.

The report was then adopted.

The Chairman moved that a dividend be declared for the half-year at the rate of 11 per cent. per annum free of income-tax.

This was seconded by Mr. Hayes Fisher, M.P., and carried.

Lord Kinnaird moved the re-election of Capt. Bax as a director, and this was agreed to, as was a motion by Mr. Wallace, K.C., for the re-election as a director of Mr. Browne Martin.

Mr. Goulding, M.P., said the success of the corporation was undoubtedly due to the zeal and ability with which the directors and staff had carried on the business. It would be remembered that there were about 400 shares remaining from the last issue of ordinary shares, and this amount was too small to be distributed round amongst the shareholders. He moved that the shares be issued to the directors, officers and staff of the corporation.

Mr. Wiedeman seconded the motion.

Mr. Reed: You mean at par?

Mr. Goulding: That is my intention.

The motion was carried, and the Chairman, in thanking the shareholders, said the staff worked well together under Prof. Kennedy and the other chiefs of departments, and it would be gratifying to them to have some recognition of their services.

Telegraph Construction and Maintenance Company.

The report of the directors for 1901, to be submitted to the meeting on the 4th prox., states that the accounts for the year show a net profit of £105,695, after charging the interest on the debentures. To this sum must be added £75,564 brought forward, making a total of £181,259. From this amount is deducted the interim dividend of 5 per cent. paid July 16th, amounting to £22,410, leaving £158,849 to be dealt with. Of this sum the directors propose to distribute a dividend of £1 4s. per share, together with a bonus of 12s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend and bonus for the year of £2 8s. per share, or 20 per cent., leaving £91,619 to be carried forward. The business of the company has been satisfactorily maintained during the year, and the factories at Wharf Road and Greenwich have been fully occupied in the manufacture of submarine telegraph cables and of insulated wire. The company's steamships have been actively engaged in the laying of submarine cables and also on cable repairing operations. The directors have entered into a contract for the building of a cable steamer, which has been named the *Colonia*. This vessel was successfully launched on the 14th inst. The *Colonia* is about 7,700 tons register, and her cable gear, machinery and general arrangements are of the most recent designs, and include the latest appliances for facilitating the work on which she will be engaged. The directors propose to add a further sum of £20,000 to the pension fund established in 1899 for the benefit of the company's staff.

Kensington and Knightsbridge Electric Lighting Company.

The directors' report to be presented at the meeting to be held at 5, Great George Street, Westminster, on Wednesday, March 5th, at 4 p.m., reads:—

"The directors submit to the shareholders a statement of the accounts of the company, together with a report of the position of the undertaking at the end of the year 1901. During the year the number of houses and shops connected with the system has increased from 2,324 on December 31st, 1900, to 2,605 on December 31st, 1901, while the number of lamps calculated on the usual basis of 8 c.p. has increased from 199,098 to 222,158. The renewal account now stands at £38,266 14s., being an increase of £292 3s. 8d. over the amount of the account at the end of the previous year. After providing for the amount placed to renewal account, and after paying the dividends on the 6 per cent. first preference shares to June 30th, 1901, on the 5 per cent. second preference shares to September 30th, 1901, and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1901 is £9,215 5s. 3d. Of the above sum £1,500 has been appropriated to the payment of the first preference dividend to the end of the year, and £625 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date. It is proposed to pay out of the balance of £7,090 5s. 3d. a further dividend on the ordinary shares of 5 per cent. for the past half-year, making, with the interim dividend paid on August 8th, 10 per cent. for the year. This will leave a balance of £1,840 5s. 3d. to be carried forward. The directors have the pleasure to report that the new generating station, which has been constructed in conjunction with the Notting Hill Electric Lighting Company, Limited, and which was available for a partial supply during the early part of the year, has been constantly used during the past nine months. Since the supply from Wood Lane has been available by means of the transformer station at Albert Hall and by other transformers at Kensington Court, which have replaced some of the steam power at that station, the battery station at Queen's Terrace Mews has been dismantled. The first cost of the batteries and plant, less amounts realised by sale, has been written off through the renewal account. The freehold of the property in Brompton Road previously held under leases has been acquired; the cost of the leases is written off from the sinking fund for leasehold property. It is with deepest regret the directors have to formally announce the death of Mr. Granville Ryder, who, from its formation, until his retirement in the Spring of 1901, had been chairman of the company, and they further have to announce with equal regret, the death of Mr. A. S. Bolton, who had been a director of the company from its foundation. They have filled the vacancy caused by the death of Mr. Ryder, by the election of Mr. G. H. Hopkinson, who had been previously on the board, and of whose services his colleagues entertained a high appreciation; they now recommend the confirmation of their choice by his re-election at this meeting. With respect to the vacancy caused by the death of Mr. Bolton, Colonel R. E. Crompton, C.B., who has resigned his position as advisory engineer, has been elected to a seat on the board, and the directors now recommend the confirmation of their choice by his re-election. The remaining directors are Sir Frederick Bramwell, Bart, F.R.S., who, on the retirement of Mr. Ryder, was appointed by his colleagues chairman of the company, Sir Charles Grant, K.C.S.I., and R. W. Wallace, Esq., K.C. Mr. Wallace retires under the articles of association, but is eligible and offers himself for re-election. The auditors, Messrs. Price, Waterhouse & Co., offer themselves for re-election."

Northampton Electric Light Company.

Alderman F. H. Thornton, who presided at the annual meeting on the 15th inst., referred to the large fall in the cost of coal, and the great economy effected by means of the water softener. These benefits had led to the increased dividend. £800 had been set aside for reserve, and this was the largest sum they had ever set aside for that purpose. The coal bill was £500 lower than in the previous year, and the sale of energy was £700 higher. The speaker proceeded to show that their efforts to encourage the demand for motive power were meeting with success. The report was adopted.

Western Telegraph Company.—The directors have declared an interim dividend of 3s. per share (6 per cent. per annum) for the quarter ended December 31st. The transfer books will be closed from March 14th to 20th.

Northwich Electric Supply Company.

In their fourth annual report the directors of the company state that the number of consumers has increased to 292, compared with 246 in the previous year. The motors added in November at the works on the Weaver were giving great satisfaction, and would be a source of considerable profit. Another large motor was being installed at the leading shipbuilding yard. Owing to the increased demand for electricity, both for light and power, the directors considered it necessary to further extend the works and put down additional plant, and for this purpose they proposed to issue £5,000 of further shares, out of the £10,000 still unissued. After making all payments, and carrying sums to depreciation and reserve accounts, a net profit for the year of £690 4s. 1d. remained. With £92 8s. 11d. brought forward from last year, there was £782 13s. available for distribution. From this the directors recommended the payment of a dividend at the rate of 4½ per cent. per annum. This would absorb £675, leaving £107 13s. to be carried forward.

The annual meeting of this company was held on Monday under the presidency of Mr. T. Ward. The chairman said that gradual progress was maintained, and that the number of lamps in use was now 12,510 8-c p. as compared with 607 in the first year of the company's existence. The installation of motors had been a feature during the year, and the Chairman, in moving the adoption of the report, commented upon the fact that Northwich possessed the first two electrical swing bridges in the kingdom, and that the Weaver Navigation had recently commenced to work the whole of their machinery by electrical power. It was found necessary to extend the works, and £5,000 further share were to be issued. After writing off £30 from preliminary expenses, and £43 off free wiring account, and setting aside £350 for depreciation, making with the £305 previously set aside a reserve fund of £655, the net profit for the year was £690. The directors recommended the payment of a dividend of 4½ per cent., which would absorb £675, and the carrying forward of £107.

The balance sheet was adopted, and Mr. W. M. Beckett, in reply to questions and criticism as to the expenses, said as compared with the previous year, the income had increased 27 per cent., and the total expenses had only increased 18 per cent., while the works expenses had only increased 15½ per cent. The total expenses of the company amounted to 2·62d. per unit, which was very much lower than any other company in England. The average allowance for depreciation was 1½ per cent., but they had allowed nearly 2 per cent., and in addition they were keeping up the plant in proper order by means of current expenditure on repairs. They beat any other company burning fuel in the kingdom.

On the motion of Mr. Rayner, seconded by Mr. Elam, it was decided to vote the sum of £100 to the directors in recognition of their five years' service during the existence of the company.

Mr. T. Ward and Mr. Saner (engineer to the Weaver Navigation), were unanimously re-elected as directors. The latter, in reply, made an interesting speech. The company was, he said, not merely a pioneer company in that district, but was a pioneer company in the whole of the kingdom, for from first to last there was not an atom of steam used. Throughout, they had adopted the Mond gas, which, although well known in the Northwich district, was practically unknown in the rest of the country. They had solved the problem of how to do without unsightly, smoky chimneys, and he recommended the consideration of this fact to the local authorities.

The meeting closed with a vote of thanks to the directors, and an intimation that in issuing fresh capital, preference would be given to existing shareholders.

Edwards Air Pump Syndicate, Limited.

Mr. C. W. Milne presided at the meeting of this syndicate on 21st inst., and in moving the adoption of the report, referred in some detail to the success which the pump had made during the year, especially among electrical engineers. The growth of the foreign business was also referred to, and a 5 per cent. dividend declared.

Marconi's Wireless Telegraph Company.

The fifth ordinary general meeting of the shareholders of this company was held on Thursday of last week, at the offices, 18, Finch Lane, Cornhill, Sir Charles Evan-Smith, K.C.B., presiding.

The Chairman, in proposing the adoption of the report, said that since they last met the chief event of the year had, of course, been the transmission of signals by wireless telegraphy at the company's station in Cornwall, to St. John's in Newfoundland, a distance of over 2,000 miles. That was an achievement which they might fairly state startled the civilised world. It marked an enormous stride forward in the development of the Marconi system, and it seemed calculated to effect such drastic changes in international communication, that it naturally called very wide-spread comment and criticism into existence. It was not unnatural that those interested in the cable companies should especially direct their attention to the present alleged shortcomings of wireless telegraphy, and the board on their part had not failed to read with all the attention they deserved those criticisms. But while welcoming them, and, indeed, while welcoming criticisms from whatever quarter they might come, they were of opinion that the point of view from which to regard wireless telegraphy was that from which they endeavoured to supervise the operations of the company, viz., that it was a system which was day by day shedding its defects, and day by day steadily and surely progressing towards its perfect adaptation to meet all the wants of the community at large. The criticisms launched against the system fell chiefly under two heads—the low-speed of working, and the absence of any secrecy in communication, but those criticisms were naturally subject to the remark that the same genius that had overcome the initial difficulties of wireless telegraphy by sending messages over an intervening space of 2,000 miles, might with some confidence be relied upon to remove the defects alluded to, and on which such stress had been laid. Any hour or moment might bring forward fresh discoveries which would render hostile criticism of that sort nugatory and ineffective. The board considered that they had good reason for relying with perfect confidence on the genius and determination of Mr. Marconi to secure for the system each and all of the advantages of which he had more than once indicated the probabilities. They

believed that nothing could now withstand his ultimate and complete success in all directions. On many grounds the operations of the past year must be considered as satisfactory. They were convinced that the system might now be considered the standard one for use throughout the world. Numerous coast stations had been erected in Great Britain and at many stations throughout the universe, and the agreement with the subsidiary undertaking—the Marconi International Marine Communication Company, Limited, would, in the course of time, really render it imperative for the entire mercantile marine to use their instruments. Passengers of all nations would benefit by the adoption of the system, to the exclusion of all other systems, for no other system could now become of any practical use to ships at sea. So far as long-distance traffic was concerned, they feared rivalry from none, but at the same time they believed that there was ample room for profitable working, both by the cable companies and by their system, and that wireless telegraphy would result in new sources of revenue being opened up to the various cable companies.

Mr. Marconi here addressed the shareholders as follows:—Among the notices that have recently appeared in the Press with regard to the progress of my system of wireless telegraphy, and in particular with regard to my latest tests over long distances, so much of a contradictory or distorted nature has been printed that I have thought that a concise and authoritative statement on the subject from myself might form a fitting part of the ordinary business of this meeting, at which I am very glad to be present. I shall first refer, if you will allow me, to my experiments in the transmission of wireless signals between England and Newfoundland. It is now nearly two years since, in consequence of improvements then recently introduced into my system, it was agreed that a trans-Atlantic experiment should be made by means of two large power stations, though at the same time I decided against any immediate disclosure of our determination, since I was not desirous of entering upon a discussion of the subject until I could satisfy myself by experiments that it could be accomplished. As you are all now aware, practical preparations to this end were initiated on both sides of the Atlantic, and by the autumn of last year we had every reason to expect that we should be in a position to make the experiment under favourable conditions. An unfortunate accident to the masts at Cape Cod seemed likely to postpone the same for several months, when I came to the conclusion that, whilst the necessary repairs there were being carried out I would use a purely temporary installation in Newfoundland for the purpose of trans-Atlantic experiment, from which I might, at any rate, be able to judge how far the arrangement of the station in Cornwall had been conducted on right lines. This experiment was, as you know, made last December, and it is a great pleasure to me to be able to inform you that it was successful. In view, however, of the action which the Anglo-American Telegraph Company saw fit to take at the time, and of the abundance of sites available elsewhere than in Newfoundland, it was thought undesirable to continue experiments which, especially if we had attempted to carry out commercial work prior to the expiration of the Anglo-American monopoly in Newfoundland, seemed not unlikely to land us in litigation, but I am glad to add that arrangements have since been concluded under which they will be continued without loss of time, with stations both in Canada, where we have been met with the most generous encouragement on the part of the Government, and in the United States. To set at rest what I cannot help calling a somewhat ill-informed doubt which I am told has been expressed in some quarters, I may mention that my next series of tests will of course include the transmission not only of single letter signals but of words also and messages. The letter S being the easiest signal in the Morse code to transmit, has been used by me in connection with my initial tests not only in this instance of signalling across the ocean, but always when I have been desirous of carrying out a first experiment over distances much greater than I had previously attempted. Over a year ago, when I succeeded in transmitting signals over a distance of 200 miles—a distance which has since been brought well within the ordinary operation of my system—the letter S was also employed as a signal in the preliminary tests. As for the suggestion that I am perhaps capable of mistaking atmospheric "strays" for the signals which I had pre-arranged should be sent to me at fixed intervals and in definite succession, I should consider myself very unfit to occupy my present position if my experience in the matter did not enable me to characterise it as ridiculous. I pass to another subject upon which there has appeared, of late, in the press, a great deal to which my last remark has equal application. I refer to the statement to which currency has recently been given among heated partisans of those cable interests, that have chosen to see in my work a menace to themselves, the statement, namely, that my system is without genuine commercial basis. It has also been asked why, since we are able to transmit signals over such a considerable distance as 2,000 miles, we have no regular work in hand over such comparatively short distances as that between England and Ireland? I will deal with the latter point first. The reply to it is, that my system is, in fact, available over such distances across sea as those named, and that the sole and simple reason why it is not in commercial use between England and Ireland, or parts of these countries, is to be found in the monopoly of telegraphic communication within the United Kingdom claimed by the British Post Office. This monopoly, however, not extending to telegraphy with places outside the three-mile limit, there is nothing to prevent our undertaking commercial work with ships at sea, or, as we believe, we shall shortly be in a position to undertake it, with Canada and the United States. Up to the present, however, whenever we have been suspected of an attempt to do any commercial work within the three-mile limit, we have not failed to receive a communication from the Post Office authorities warning us, under pains and penalties, against an infringement of the monopoly claimed by H.M.'s Postmaster-General. As summarising the alleged objections to my system on which their authors proceed to found the statement to which I have alluded, that it is without genuine commercial basis, I will take two so-called expert opinions cited by Sir John Wolfe Barry a week or two ago in his address from the chair to the shareholders of the Eastern Telegraph Company, and quoted also by Mr. Francis Bevan at the meeting of the Anglo-American Telegraph Company. Allow me to read them to you. The first runs as follows:—"Causes of disturbance, which may, or may not, be remedied in the future, are at present existent, and fatal to the establishment of a practical and reliable system of commercial (wireless) telegraphy. I am, therefore, very clearly of opinion that submarine cable enterprise has nothing to fear, in a commercial sense, from the competition of ætheric telegraphy." The second reads thus:—"To the best of my belief, submarine cables will for a long time be pre-eminent for the purpose of long-distance telegraphy. It is manifest that wireless or open methods cannot compete, in point of secrecy or certainty, with closed or cable methods, and could only compete with them in point of speed and accuracy by aid of great improvements and new inventions involving little less than discoveries." The first of these passages which I have read to you is from the pen of Sir W. H. Preece; the second represents the opinion of Prof. Oliver Lodge. Now, as these utterances have been quoted as illustrative of the highest expert opinion, and since their publication, have furnished the text for many paragraphs at least semi-hostile to my system and to the work of this company, it becomes interesting to inquire what the qualifications of these gentlemen for the criticism of my system of wireless telegraphy may be. Sir W. H. Preece is, I believe, a gentleman with various claims to scientific distinction, but whatever his attainments in other walks of science, I regret to say that the most careful examination reveals absolutely no testimonial to his competency for this most recent of his undertakings. Such knowledge of my work as he may possess is at least three years old—a very long period, I would remind you, in the brief history of my system. Three years ago, the most important adjunct of its later phases, the tuning of installations, had not yet been introduced. The system was, in a word, in its infancy. I am not sure what opportunities Sir W. H. Preece had of studying it at work during that early stage, but I can assert positively that he has been in no station of mine, nor had any opportunity whatever of studying its practical working since the changes, amounting almost to a revolution, which have been accomplished during the last year or two. Of the conditions under which the system is now worked, Sir W. H. Preece is, in fact, wholly ignorant. I regret to say that, distinguished as Dr. Lodge may be as a professor of physics, or as a student of physical phenomena, the same statement applies also in his case, so far as my present system of wireless telegraphy is concerned. Notwithstanding Dr. Lodge's early and felicitous appreciation of myself as "a young man with a secret box and a sense of humour," he has, I believe, developed a commercial interest in wireless telegraphy since the results of my work in it began to be published, and has taken out sundry patents in connection with the subject, although, so far as I am aware, none of them are at present employed for the purposes of any permanent installation of wireless telegraphy. However this may be, Dr. Lodge has had no opportunity of seeing and familiarising himself with the working of any of my apparatus of a type later than that which was in use in the year 1899. In that year, he had, I remember, an opportunity to observe the working of the earlier type of apparatus between Dover and Boulogne, upon the occasion of the meeting of the British Association in the former town, and he is good enough to mention in one of his books that it then "appeared to work dependably." One might have supposed that Dr. Lodge, writing three years later upon that observation, would have at least been able to admit the conceivability of that same "apparent" reliability having been in the meantime somewhat developed and increased. So far as the passages which I have read to you represent simply a defence of cables, I am in no way concerned with them in this place, though I may remark that the progress of wireless telegraphy in the future will have apparently to be achieved to some extent, despite the opposition of enormous vested interests, nothing analogous to which was in existence to handicap the early progress of the established cable system. I have much regretted to observe the hostile attitude assumed by a certain portion of the press of this country towards my system, which, though new, is, I am convinced, come to stay, and that, I trust, to the permanent benefit of humanity at large, even though, unfortunately, no rise may be caused by it in the price of cable stock. I say *a portion* of the Press, for the tone to which I refer has, in fact, I may almost say, been confined to a portion of the English electrical press which seems vowed to the exclusive support of cable interests, whilst from the technical Press of other countries, especially from that of Canada and of the United States, I have received much sympathetic appreciation and encouragement for which I have felt warmly grateful. The reprinted report which you have in your hands of the proceedings at a gathering of the American Institute of Electrical Engineers, as reported by the *Electrical Review* of New York, will, I think, sufficiently illustrate my point. I must also, however, cordially recognise the sympathetic and encouraging tone in which most of the great English daily papers, such as the *Times* and many magazines, have written concerning my work. I have endeavoured to find in these criticisms some consolation for the pungency of those of an opposite character. So far, however, it has not seemed necessary for us to start a paper of our own for the *ex parte* presentment to the public of our views, prospects and opinions. I pass now to the main items of these indictments of my system, which, if they could, would disqualify it as a commercial system, and particularly as a commercial system for use over long distances, on the grounds of lack of secrecy,

of speed and of general reliability. Well, gentlemen, bare facts are the best answer to allegations of this sort, so I shall simply mention that so far from these suggestions which have been widely made in what I may call cable circles being true, my system is at the present moment in precisely that permanent use which they would deny it, upon over 70 ships, and at 25 land stations in regular every-day work. Nor, it must be admitted, do all, even in those same cable circles, appear to be insensible to the weight of such a consideration as this, since, as I was interested to note, Mr. Ward, the chairman of the Commercial Cable Company; stated before the Pacific Cable Committee of the American Congress that if the result of my trans-Atlantic experiment had been known earlier, he doubted whether the new Pacific cable would have been undertaken. One failure, indeed, I regret to have to chronicle. I refer to the operations of the local company which was formed nearly three years ago to work the system in the Sandwich Islands. That failure, however, was wholly due to the inferior class of the operators—frequently ignorant half-breeds and negroes—whom the Hawaii Company was ill-advised enough to employ for reasons of very false economy. It casts no discredit on the system, but only on a company for whose operations we were in no way responsible, and I do not think that it is a matter which we need allow in any way to disturb us. Returning to the question of commercial working, I may mention that it is no uncommon thing for the messages passing to and from a liner, either outward or homeward bound, to realise, apart from service messages, a sum of from £30 to £40. Upon a recent arrival of one of the American liners in home waters no less than 8,050 words were transmitted and received within the space of 16 hours. I would point out that if in each complete day of 24 hours only that same number of words should be transmitted between two of our trans-Atlantic stations—and the supposition is surely not an extravagant one—that, at 6d. a word, would represent an annual income of over £73,000 from each pair of such stations, of which in the first instance we are proceeding to instal two pairs. I think it is obvious from such facts as those I have mentioned, and as are presented to you in concise form in your directors' report, that the allegation that we are not working on a commercial basis is incorrect. As to the general trustworthiness of the system which Messrs. Lodge and Preece seem to doubt, I may remind you that even upon its earlier initial working, so long as three years ago, the Deputy Master of Trinity House, reporting on its operation at the East Goodwin Lightship, publicly stated before the Institution of Electrical Engineers at their meeting on March 22nd, 1899, that he had never known it once to fail, though, if failure there had been, it must have come to his knowledge. The U.S. Consul at Ostend, in Belgium, also, as I see by a report that appeared in the New York *Electrical Review* on December 20th, 1900, reported to his Government that the system, as in use upon the Belgian mailboats, worked as reliably as any ordinary land wire station. I remark, allow me to say here, a noticeable change in the character of the objections on which this old charge of absence of commercial practicability in my system is now based. Three years ago we were met chiefly by allegations of material difficulties which have, however, in the event, proved to be purely hypothetical. At the time, as I remember, when the first wireless messages were transmitted across the English Channel, a certain sensation was caused in the cable world, and it was freely stated that to secure the transmission of messages across the Atlantic Ocean I should require poles something like 200 miles high. I hear nothing of that sort now. Instead, we have such statements as those to which I have been calling your attention relative to speed, secrecy, and so forth. The wish is sometimes father to the thought, as we know, and one is really tempted to see in the old proverb some explanation of the ready way in which these new objections are—I can only say—imagined. With regard to the speed of wireless transmission, I have seen it stated to be six words a minute, whereas, in the same space of time, by cable across the Atlantic, about 40 words can be transmitted in the most favourable case, a more ordinary speed being less than half that number. In point of fact, with my latest apparatus I am able to transmit 22 words a minute, and I need but observe that in the early days of the cable system the transmission of even *one* word a minute over a cable was only accomplished with great difficulty. I am not sure, therefore, that their present accomplishment, after 50 years' development, provides an altogether overwhelming comparison with my own 22 words a minute after not many more than the same number of months. Also one most important fact must be borne in mind, that whereas the speed of the submarine cable is directly affected by length, the speed of working of the wireless system is not affected in the least by distance. It is just as easy to work at a high speed across the Atlantic or across the Pacific as to work across the English Channel. With a submarine cable, however, unless the outlay on copper is increased in almost geometrical proportion, the speed of working over a long distance is relatively shortened. I have reserved till last the objection which, were it well based, would be the most serious that has been brought against my system, viz., that under it the secrecy of messages is impossible. I am not disinclined to admit that in the earlier stages of the system's development this objection might have been advanced with some cause, to remove which, accordingly, became an important object of my researches. I am happy to state that these have been successful, and that to the latest phases of my system that objection has become to all practical intents and purposes entirely inapplicable, the difficulty in question having been found to be satisfactorily overcome by the adoption of syntonic devices. These are not employed as yet by the British Admiralty, but I am sure that you will be pleased to learn that I am now able to transmit messages between England and Ireland, *i.e.*, over a distance of 200 miles, as I am confident of being able to do it with equal, if not even greater, facility across the ocean without interfering with, or, under ordinary conditions, being interfered with by any ship working its own wireless installation between my stations or elsewhere. As an illustration of the point to which tuning has been already developed, I may mention that the Lizard station is at present able to work with ships without suffering any interference at all from the contemporary working of the big power station at Poldhu, only seven miles away. The latter, apart from tuning, would entirely prevent any such independent working of the Lizard station. I will not say that under no possible combination of circumstances could such a wireless tuned message be tapped, or interfered with, but I would remind you that such a statement would be no more true of cables and telephones than in the case of my wireless system. One would imagine from all this talk about secrecy, and freedom from interference, that these were the absolute possessions of the cable system. Nothing, of course, could be more inaccurate than such a supposition. As an instance, I may remark that only about two years ago at Cape Town it was found impossible to work the cables landing there during the hours when the electrical tramways of the town were running, and the matter became subsequently the subject of litigation between the companies concerned. Again, Prof. Lodge himself, in a report of his experiments in magnetic space telegraphy, mentions that one of their results was to interfere with the working of the ordinary wire telephone system in the city of Liverpool. Sir W. H. Preece has also published results which go to show that it is possible to pick up at a distance on another circuit the conversation which may be passing through a telephone wire. Again, when a few years ago, at Deptford, an accident occurred to the electric lighting station through the earthing of some high tension conductors, so much disturbance was caused in telegraph circuits all round, that it became the occasion of great inconvenience throughout the London district, and effects of it were felt so far south as Paris and so far north as Leicester. All this goes to show that the established methods of wire telegraphy and telephony are liable, in a certain measure, to accidental or wilful interruption caused by disturbing currents and inductive effects which may, to use a popular expression, be let loose in the vicinity. When working wireless telegraphy for the America Cup yacht races, we were subjected to the wilful interference of a certain party, whose aims were openly exposed by the *New York Herald*. As for cable interruptions, I cannot open a technical journal any week without finding a list, more or less long, of cable interruptions in various parts of the world. In the case of the Atlantic cables, it is true, such interruptions are not apt to be felt, for the simple reason that there are 13 or 14 cables laid across that part of the ocean, and even if two or three broke down the traffic would go through those that remained intact without the public noticing any delay. But in parts of the world where communication is dependent upon a single cable, as in many parts of South America and elsewhere, for instance, to take an example near home, in Jersey, where the cable service was interrupted only the other day, very great inconvenience is frequently caused by cable breakdowns, which if they are sufficiently frequent now, were vastly more numerous, of course, when cables were still at a stage corresponding to the present point of development of wireless telegraphy. Cables, too, are apt to be cut, and are subject to the numberless risks of interruption from which we have seen them suffer so frequently during the course of the present struggle in South Africa. I leave England the day after to-morrow for Canada, for the purpose of concluding certain business negotiations, already settled in principle between ourselves and the Government of the Dominion, from which I received during my recent visit the most kindly and appreciate welcome. I expect to be back in England about the end of March, and if, after my return, either Sir W. H. Preece or Prof. Lodge, being of the opinion that within a space of, say, a week, after due notice given to me, he could succeed in intercepting and reading messages to be provably transmitted by me at stated times within that period, between two of my stations, if I say, either of these gentlemen would like to try the experiment, I shall be happy to place any adjacent station of mine at his disposal for the purpose. If he should prefer to conduct his operations from a ship, he would, so far as I am concerned, be quite welcome to do so. In either case, I should expect a result which might convey to the shareholders of the Eastern Telegraph Company a somewhat more accurate idea than they seem to possess as to the exact measure of the competency of their learned advisers to pronounce an opinion upon my present system of wireless telegraphy. Gentlemen, I apologise for having detained you so long. I am glad, however, to have been able to speak to you with such assurance of the past, and with such confidence of the future of my system. I believe that I am not given to over sanguine expectation or to exaggerated speech, and I trust, therefore, that I may be suspected of neither, if, in conclusion, I venture to express the extreme gratification which it affords me to be associated with the development of a system—despite our critics, a commercial system—of wireless telegraphy, from which, however, I confidently anticipate greater results even than the payment of that substantial dividend for which I believe we may soon look, and which is, naturally, the first object of a commercial company like our own—results, namely, in good service not only to this Empire, but to the whole of the civilised globe, to be achieved, as such service indisputably is achieved, by the placing of new means of communication at the disposal and within the reach of an indefinitely wider public for social as well as for commercial ends, by new benefits conferred upon the great shipping interests of this and other countries, and by a diminution in loss of life and property at sea. By the cheapening in the method of communication between them, I think we may also fairly claim that we are doing something to strengthen the bond that unites the two great English-speaking communities of the world.

The report was adopted.

Oxford Electric Company.

THE directors' report, to be submitted at the general meeting, to be held at the Randolph Hotel, Oxford, on Friday, March 7th, reads as follows:—

The directors beg to submit their report and accounts for the year ending December 31st, 1901. The revenue account shows a profit (including £155 11s. 10d. brought forward from last year) of £5,966. After providing £2,050 15s. 4d. for debenture charges and other interest, and writing off £450 6s. 5d. on account of hire purchase installations, the available balance net profit is £3,464 19s. 3d., which your directors propose to appropriate as follows:—In payment of a dividend at the rate of 5 per cent. per annum on the share capital, £2,855 2s. 9d., and in adding £500 to the reserve and the renewal of plant account (which will then amount to £2,500), leaving £109 16s. 6d. to be carried forward to next year's account. Since the last report, 7,198 8-C.P. lamps (or their equivalent) have been connected to the mains. The largest number added in any previous year has been 4,564 8-C.P. On December 31st last the total number of lamps on the system equalled 40,458 8 C.P. The number of units sold has been nearly 18 per cent. more than in 1900, and the revenue from sales by meter shows an increase of £1,890 10s. 8d. over that of the preceding year. To meet the increased demand, a new unit of 225-KW. capacity has been installed at Osney Works, and three additional transforming stations, situated in George Street, Christ Church and Walton Street, have been erected and equipped. To cope with the North Oxford demand, another sub-station is in course of construction in Staverton Road. In addition to the increase in the high tension system of mains to connect the new transforming stations with the generating station, the distributing mains of the company have been extended in the Banbury, Woodstock, Chalfont, Keble, and Staverton Roads, and in St. Aldate's and Oriel Streets for the supply of Christ Church. The plant has been maintained in thoroughly efficient order, and during the year two of the three original boilers have been fitted with new fire-boxes, at a cost of nearly £500; this expenditure has been charged against revenue. The retiring directors are Mr. L. A. Selby Bigge, M.A., and Mr. J. Irving Courtenay, M.A., who are eligible for re-election.

The Bristol Tramways and Carriage Company.

THE report of the directors, which was presented at the meeting held at the Grand Hotel, Broad Street, Bristol, last week, reads as follows:—

The directors have pleasure in submitting to the shareholders their report, with a statement of the accounts, for the year ending December 31st, 1901. The gross receipts for the year amount to £213,967 8s. 2d., and the working and general expenses and renewals are £143,584 8s. 8d., leaving a net revenue of £70,382 19s. 6d.

The following amounts have already been distributed, viz.:—

Interest on 4 per cent. mortgage debenture stock and temporary loans	£9,943 9 11	
Dividend on 4 per cent. preference shares and interest on calls paid in advance	12,576 14 10	
Interim dividend at the rate of 8 per cent. per annum (subject to income-tax) for the half-year ending June 30th	18,916 13 4	
		£41,436 18 1

And it is proposed to appropriate the balance as follows:—

Final dividend for half-year at the rate of 9 per cent. per annum (subject to income-tax) ..	£21,187 10 0	
To carry to reserve and renewal funds:—		
Leased premises redemption ..	£500 0 0	
Electrical renewals	1,500 0 0	
Contingencies	5,758 11 5	
	£7,758 11 5	
		£28,946 1 5
		£70,382 19 6

The reserve funds will then amount to £99,261 1s. 9d.

The receipts from the tramways department show the important increase of £17,696, and those of the carriage department an increase of £185. The total number of passengers carried during the year on the company's cars and omnibuses was 36,714,906, which is approximately 10 millions more than in the previous year. The accounts now presented cover the first complete year's operation of the company's system since the general adoption of electric traction, and the great expansion in the traffic receipts and number of passengers carried affords an illustration of the vastly improved service which the introduction of the new form of traction enables the company to render to the public. The results of the initial period would have been even more favourable but for the one untoward episode that is common knowledge amongst local shareholders. During the height of the summer season designs were made upon the loyalty of the company's staff, which involved about 450 of the employés and culminated in a strike on the eve of the August Bank Holiday. Prompt and effective measures were taken, however, to replace the malcontents and minimise public inconvenience, though necessarily during the few weeks of public excitement the abnormal circumstances entailed some loss of traffic and special expenditure. Since the close of the year under review, arrangements have been completed for discontinuing the use of the suburban generating station at St. George, so that the whole of the eastern lines formerly operated from that source are now worked with the main system from the central power station at Counterslip, the change being attended with many advantages in supervision and effecting substantial economy. The Corporation of Bristol recently appointed a committee of the Council to consider and report as to the possibility of acquiring the company's undertaking. The Council having made their intention quite clear that the proposal was in no way with the object of compulsory purchase, but only for the acquisition if at all by agreement with the company, the directors expressed their willingness to facilitate the Committee's inquiry, though they could not make any offer of the undertaking. The matter did not, however, proceed beyond a preliminary stage, as the Committee were unprepared to formulate such an offer as the directors would be likely to recommend the shareholders to accept. On the last issue of preference capital, 20,000 new shares were subscribed amongst the proprietors of the company. It is the intention of the directors to forthwith issue the remaining 5,000 preference shares, reserving the privilege of application for them, at par, in favour of the proprietors on the registers at March 1st prox. Mr. George White, director, and Mr. Solomon Hare, auditor, retire at the ensuing meeting, and offer themselves for re-election. The dividend warrants will be posted to the shareholders on February 25th inst.

Hart Accumulator Company.

THE report of the directors for 1901, which was presented to the meeting held at Stratford on the 26th inst., states that the profit for the year is £7,875 and the balance brought forward from last year £1,492, amounting together to £9,367. The directors recommend a dividend of 12½ per cent. per annum on the ordinary share capital, which will absorb £4,937, leaving £4,430 to be carried forward. The company's buildings, plant, tools, &c., have been augmented by £1,478, which has been charged to capital, and due depreciation on same has been made. The maintenance of the works, plant, &c., has been well kept up at a cost of £606, which has been paid for out of revenue.

Blackpool and Fleetwood Tramroad Company.

THE half-yearly meeting was held at Manchester on 21st inst., Mr. George Richardson being in the chair.

In moving the adoption of the report, which recommended a dividend at the rate of 9 per cent. per annum, the CHAIRMAN said that the number of passengers showed an increase, and the car mileage run also showed an increase for the half-year. Compared with the corresponding half of the previous year, there had been a decrease in the expenses of about £200. The season ticket holders were increasing in number.

The report was adopted.

W. T. Henley's Telegraph Works Company, Limited.

THE following statement has been placed in circulation by this company:—

"DEAR SIR (OR MADAM).—It has been our custom to hold the annual ordinary general meeting of the company in the last week of February, and to present the accounts for the past year to that meeting and declare a final dividend. But, as you have probably heard, negotiations have been for some time going on with the directors of Messrs. Callender's Cable and Construction Company, Limited, for the amalgamation of the two companies by merging them both in a new company to be formed for that purpose. The terms have now been generally agreed, and the solicitors are preparing the contract for adoption by the two boards, subject, of course, to the approval of both classes of shareholders of each company, to whom it will be submitted at special meetings to be called for the purpose of considering it. In these circumstances your directors have thought it advisable to postpone the ordinary general meeting until the whole matter can be brought before the shareholders. Meanwhile, however, the directors have satisfied themselves that a dividend of 20 per cent. for 1901 on the ordinary shares is fully justified by the accounts, and, therefore, an interim dividend of 5 per cent. having been paid on September 1st, the board has this day declared a further interim dividend of 10 per cent., and purpose to submit to the ordinary annual meeting, with the accounts, a proposal to declare a final dividend of 5 per cent., making 20 per cent. in all. The full dividend on the preference shares for the half-year ending December 31st, 1901, at the rate of 4½ per cent. per annum, will be paid, as usual, on March 1st, 1902.

"Yours faithfully,

"A. E. SALMON, *Secretary*."

Chelsea Electricity Supply Company.

THE directors' report to be presented to the meeting which is to be held on Wednesday, March 5th, reads as follows:—"The directors beg to submit to the shareholders the report and statement of accounts for the year ended December 31st, 1901. The profit for the year amounts to £23,564 17s. 5d., which, with £190 13s. 1d. balance of interest and £121 17s. brought forward, makes a total of £23,877 7s. 6d. After deducting £6,750 interest on debenture stock, £900 interim dividend on the preference shares, and £4,902 5s. interim dividend on the ordinary shares at the rate of 5 per cent. per annum, there remains a balance of £11,325 2s. 6d., which the directors recommend shall be appropriated as follows:—

To credit of renewals and depreciation fund (as against £3,000 for 1900)	£6,500 0 0	
To final dividend on the preference shares at the rate of 6 per cent. per annum, making 6 per cent. for the year ..	900 0 0	
To final dividend on the ordinary shares at the rate of 3 per cent. per annum, making 4 per cent. for the year	3,463 3 0	
Leaving a balance to be carried to the next account of ..	461 19 6	
	£11,325 2 6	

The reduction of the dividend on the ordinary shares is not due to any diminution in the net profit, which, on the contrary, has increased by £2,756 10s. 6d., notwithstanding an increase in the rates and taxes (which now amount to £2,642 9s. 4d. as against £1,453 5s. 9d., as a result of the recent quinquennial re-valuation), but to the decision of the directors to place to the credit of the depreciation fund a considerably larger sum than in past years. The question of an adequate appropriation to this fund is one which has for some time engaged the earnest attention of the directors. They have, until lately, been of opinion that the improvement in the company's business from year to year would allow of a regular increase in the amount set aside for depreciation, without disturbing the rate of dividend paid to the ordinary shareholders; but they regret that the annual improvement in the company's revenue has not been sufficiently rapid to confirm this view. It will be within the recollection of the shareholders that the company has in the past suffered considerably from claims arising out of vibration and from other causes. These troubles, the directors believe, have at last come to an end, and they have had under their consideration the question as to how the losses caused thereby can be best dealt with. They have also had before them the general question of the present value of the plant and property of the company, and have come to the conclusion that £56,495 9s. 6d. of the capital expended is not now represented by existing assets. They have decided that this sum should be written off capital account by an appropriation from the reserve fund, and that the balance of the reserve fund should be applied to further strengthen the renewals and depreciation fund. These adjustments have been given effect to in the accounts now presented. Expenditure amounting to £764 10s. was incurred during the year in connection with the appeal to Quarter Sessions against the heavy increase in the rating assessment, and the inquiry before the Board of

Trade in the matter of changing the system of supply to a higher voltage. One-fifth of this amount has been charged against revenue in the present accounts, and the balance has been placed to a suspense account, which the directors propose to write off during the next four years. 631 ordinary shares were allotted during the year, the price being £6 per share. The number of lamps connected on December 31st, 1901, was 161,031, an addition of 15,754 during the year. The directors are glad to report a steady improvement in the units sold per 8-C.P. lamp, the number in 1901 being 12½, as against 11½ in 1900 and 11 in 1899. The total number of units sold in 1901 was 2,011,150, being 339,124 more than the previous year. Mr. William Page and Mr. William Reginald Davies have been elected directors during the year, and the shareholders will be asked to confirm the appointments. The retiring directors, Mr. J. Irving Courtenay and Major-General C. E. Webber, C.B., offer themselves for re-election. The auditors, Messrs. Cooper Brothers and Co., offer themselves for re-election."

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending Feb. 21st were £556; corresponding week last year, £541; increase, £15. Total to date, £4,483; corresponding period last year, £3,928; increase £505. Miles of track open, 10½.

Blackpool and Fleetwood Tramways.—The receipts for the week ending February 22nd were £130; corresponding week last year, £139; decrease, £9. Total receipts to date, £1,151; corresponding period last year, £1,089; increase, £62.

Bristol Tramways and Carriage Company.—The receipts for the week ending February 21st were £3,582; corresponding period last year £3,462; increase, £120.

British Electric Traction Company.—The following returns are issued of the undertakings of this company for the week ending February 14th :—

Company.	Amount £	Comparison with corresponding week of last year. + £	Comparison with corresponding week of last year. — £	No. of weeks.	Aggregate. Amount. £	Aggregate. Inc. or Dec. + £	Aggregate. Inc. or Dec. — £
Croydon *	628	468	—	6½	4,060	2,721	—
Devonport ‡	354	—	—	6½	2,437	—	—
Dudley—Stourbridge	563	78	—	6½	3,786	707	—
Gateshead ‡	583	—	—	6½	3,932	—	—
Greenock-Pt. Glasgow	306	157	—	6½	2,202	1,115	—
Hartlepool	139	—	28	6½	1,039	—	21
Kidderminster ..	83	5	—	6½	550	48	—
Merthyr ‡	177	—	—	6½	1,154	—	—
Oldham—Ashton ..	384	—	47	6½	2,790	—	111
Poole ‡	165	—	—	6½	1,097	—	—
Potteries	1,255	25	—	6½	8,410	230	—
Southport	107	8	—	6½	742	106	—
South Staffordshire†	633	—	22	6½	4,349	197	—
Swansea	360	13	—	6½	2,465	176	—
Taunton	46	—	—	6½	316	—	—
Tynemouth ‡	156	—	—	6½	1,133	—	—
Wolverhampton Dist.	117	74	—	6½	726	454	—

* Partly horse. † Partly steam. ‡ Not in operation last year.

Central London Railway.—The receipts for the week ending Feb. 22nd were £6,636; corresponding week last year, £5,941; increase, £695. Total receipts to date, £52,781; corresponding period last year, £48,779; increase, £4,002. Miles open, 6.

City and South London Railway.—The receipts for the week ending Feb. 23rd were £3,024; corresponding week last year, £2,055; increase, £969. Total receipts to date (8 weeks), £24,336; corresponding period last year, £16,189; increase, £8,197. Miles open, 6½; last year, 4½.

Dover Corporation Tramways.—The receipts for the week ending February 22nd were £150 4s. 9d.; corresponding week last year, £145 14s. 3½d.; increase, £4 10s. 5½d. Total to date, £1,273 18s. 7d.; corresponding period last year, £1,214 17s. 10½d.; increase, £59 0s. 8½d. Miles of track open, 3. Car miles run, 1902, 5,088; 1901, 4,980. Number of cars, 1902, 12; 1901, 11.

Dublin United Tramways Company.—The receipts for the week ending February 21st were as follows:—D.U.T. Co., £3,045 9s. 8d.; D.S.D. Co., £625 2s. 8d.; total, £2,670 12s. 4d.; corresponding week last year—D.U.T. Co., £2,932 7s. 3d.; D.S.D. Co., £641 16s. 3d.; total, £3,574 3s. 6d.; increase, £96 8s. 10d.; aggregate to date, £29,355 14s. 9d.; last year, £28,302 4s. 8d.; increase, £1,053 10s. 1d. Mileage worked 46.

Glasgow Corporation Tramways.—Week ending February 22nd, 1902, £10,143; compared with £8,034 same period last year. Aggregate to date since June 1st, 1901, £453,723; increase £101,642.

Liverpool Overhead Railway.—The receipts for the week ending February 23rd were £1,344; corresponding week last year, £1,420; decrease, £76. Total to date £10,790; corresponding period last year, £11,757; decrease, £967. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

A good deal of money has had to be withdrawn from the investment markets in order to provide funds for taking up Kaffir shares and to pay losses incurred in South Africans. The money market itself is fairly easy, despite the number of calls which become due in the next few weeks, but in the Stock Exchange money has commanded between 7 and 10 per cent. in many cases, members being only too glad to get accommodation at anything between these rates.

The depletion of cash has led to some little selling of Electricity Supply shares this week, but, on the whole, prices are not much changed. Metropolitans are 10s. down, and their example was followed by Notting Hills. Kensingtons lost ½ upon the unexpected reduction in the dividend. Chelsea shares are not altered, notwithstanding the disappointing character of the report and dividend. The latter, at the rate of 3 per cent. per annum, makes up 4 per cent. for the year, against 5½ in 1900. The profit is, indeed, some £2,000 higher for the twelvemonth just closed, but the board is making heavy appropriations to the depreciation and the renewal funds. In face of the fact that £56,000 worth of the company's plant and property is not now represented by existing assets (the amount being transferred from the reserve fund), the showing appears more unsatisfactory than it really is. Of course this line should have been adopted years ago, when the Cadogan station was closed.

A fresh fall in the Telegraph market, bred of renewed Marconi fears, is the principal feature of this week's electrical markets. Eastern Ordinary, Eastern Extension, Cuba, Anglo-American and Direct United States, have all given way on the sensational results which are expected to be obtained by the new system. We wax weary of repeating that these relapses are wholly unnecessary, and if investors like to lose their money by sales of their shares on account of a scare, they have only themselves to thank for it. The Anglo-American companies should be doing very well at this particular time of the German Prince's visit to America, but the stocks are quite without backbone, and the very appearance of a possible seller in the market is quite sufficient to depress prices. The Eastern group is more susceptible to lowering influences than usual, in consequence of the coming reduction in the word rate to India. The report of the Inter-Departmental Committee on Cable Communications, published the other day, shows that a definite agreement has been come to between the India Office, the Eastern Telegraph Company, and the Indo-European Telegraph Company. It will astonish other people besides the surprised Committee to hear that although the Eastern Telegraph Company has a complete independent system of cables from London to Bombay, the assent of Russia and Germany was required before the reduction in the rate could be carried into effect, though we think the position was pretty generally understood in telegraph circles.

Submarine Cables Trust certificates are almost the only things in the telegraph list to record any advance, which is limited in their case to a point. West African Telegraph shares are 1½ to 2½. It is interesting to note that Mr. C. S. Shepherd, one of the largest proprietors in the Western Union Telegraph Company, has a seat on the board of the recently constituted Great Britain Railway and Development Corporation, an American undertaking which is about to invade our shores with a view to linking up our important towns by means of electrical railways.

Globe Telegraph Ordinary shares are dull, in sympathy with the rest of the telegraph market, but the Preference are without fluctuation. Marconi shares are 3.

The amalgamation between Callender's and Henley's, to which we referred last week, was confirmed on the next day by the appearance of an official circular from the Henley's Company. Callender's have risen ½ on the long-expected consummation, but Henley's were put up a week or two ago in anticipation of the event. The latter shares now carry a final dividend, making 20 per cent. for the whole of 1901, the same rate as that paid in the previous year. The Telegraph Construction Company had an exceptionally good time in 1901, and its report shows an increased profit of £5,500, enabling the distribution of another 17½ per cent. dividend for the full year, the allocation of £20,000 to the pension fund, and a substantial amount to be carried forward.

Electrical railway ordinary issues are unchanged with the exception of Central London Deferred, which has slightly weakened, owing to apprehensions of the company's extension Bill being thrown out. By the same token, District stock is harder, and Metropolitan is being bought. City and South London keeps at 67, but its Preference issues are each 1 per cent. better. A line of Great Northern and City Electric Preferred shares changed hands at 8½ this week. The purchasers were Continental investors. By neglecting to comply with some of the Standing Orders, the Bill for the new electric railway to Brighton runs a very good chance of being shelved for the season. British Electric Traction are dullish; the Ordinary shares are ½ lower, and the market is growing suspicious of the incessant selling from mysterious quarters.

National Telephone Preferred and Deferred stocks are 100 and 62 respectively. The company's Third Preference shares have hardened a fraction, but the active canvassing for subscribers to the Post Office telephone system which is now going on is not liked by the National's supporters in the market.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations Feb. 19th.	Closing Quotation Feb. 26th.	Business done during week ended Feb. 26th, 1902. Highest.	Lowest
82,300	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	...	...	...	3½— 4½	3½— 4½	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	70 — 80	70 — 80	...	...
804,720	Anglo-American Telegraph	Stock	7s/6	3½%	6¼s.	49 — 51 xd	48 — 50	49½	...
3,097,640	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	92 — 93 xd	89½ — 90½	92½	89¾
3,097,640	Do. do. Deferred	Stock	£1 7s.	5s.%	2s.	7½— 8 xd	7½— 7¾	7⅞	7½
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	...	3½— 4	3½— 4	...	...
13,333,300$	Commercial Cable	$100	8 %	...	...	165 —170	165 —170	...	...
1,741,029£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	96 — 99	96 — 99	98½	97⅞
16,000	Cuba Telegraph	10	7 %	...	...	5 — 6	4½ — 5½	...	...
6,000	Do. 10 % Pref.	10	...	...	...	13 — 14	13 — 14	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	8½— 9½	8½— 9½	8⅛	...
30,000£	Do. do. 4½ % Debs.	50	...	...	...	98 —102	98 —102	...	...
60,710£	Direct United States Cable	20	3½%	3½%	...	10 — 10½	9½ — 10½	10	9⅞
101,300£	Direct West India Cable, 4½ % Reg. Deb., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	134 —139	130 —135	137	130½
1,930,807	Do. 3½ % Pref. Stock	100	...	...	...	89 — 91	86 — 89	89	87
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	109 —113	108 —112	111	108
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	...	13½— 14	13 — 13½	13⅝	13
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	109 —114	109 —114	...	..
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	5¼%	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103	100 —103 %	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	...	9½— 10 xd	9½— 9⅝	9¾	9½
180,042	Do. do. 6 % Pref.	10	...	...	...	13½— 14 xd	13⅝— 14½	14⅛	13¾
150,000	Great Northern Telegraph, of Copenhagen	10	...	15 %	...	28 — 30	28 — 30	...	...
75,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —103	99 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	38 — 42	38 — 42	41	...
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	102 —105	102 —105	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	2½%	...	...	½— ⅝	½— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	...	...	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	5 %	5 %	5 %	... — ...	... — ...	...	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¾— 5	4⅞— 5⅛	4 15/16	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	93 — 96	93 — 96	95¼	...
500,000£	Do. 4 % Deb. Stock Red.	100	...	4 %	4 %	101 —105	101 —105	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	6 %	...	⅞— 1	⅞— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7 — 8	7	...
3,303	Submarine Cables Trust	Cert.	...	...	...	118 —124	119 —125	...	...
58,000	United River Plate Telephone	5	7 %	...	...	4¾— 5¼	4¾— 5¼	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4½— 5	4½— 5	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	102 —105	102 —105	...	...
155,600	West African Telegraph, 5 % Debs.	100	...	...	...	100 —103	100 —103	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	⅜— ⅜	⅜— ⅜	...	...
150,000£	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13 — 13½	12½— 13	13	12½
75,000£	Do do. 5 % Debs. 2nd series, 1906	100	...	...	...	102 —105	102 —105	...	...
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	100 —103	100 —103	...	...
88,321	West India and Panama Telegraph	10	5%	...	...	⅝— ¾	⅝— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	...	...	...	5½— 6	5½— 6	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	...	...	...	3½— 4½	3½— 4½	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	100 —103	100 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

100,000	Blackheath and Greenwich Dist. Electric Light, Ord.	1	...	...	...	⅝— ⅝	⅝— ⅝	...	...
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	...	...	...	100 — 105	100 —105	...	...
19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	8 %	9¼— 9¾	9¼— 9⅜	...	...
20,000	Do. do. 7 % Cum. Pref.	5	...	...	...	9 — 9½	9 — 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	9 %	9 %	10 %	8½— 9½	8½— 9½	9⅜	9¼
50,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅝xd	5¼— 5⅝	5¼	...
250,000	Do. do. do. 4% Deb. Stock Red.	100	...	...	...	103 —105	103 —105	105	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	5½%	4 %	5 — 5½	5 — 5½	...	...
150,000£	Do. do. do. % Deb. Stock Red.	Stock	...	...	...	109 —112	109 —112	112	111
70,579	City of London Electric Lighting, Ord. 40,001—110,579	10	4 %	0 %	5 %	9½— 10½	9½— 10½	9 11/16	9 9/16
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13	12 — 13	11 13/16	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	123 —128	123 —128	...	...
200,000	Do. 4½ % 2nd Deb. Stock, Prov. Certs., all paid	100	...	...	...	101 —104	101 —104	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	4 %	4 %	...	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	12 — 13	12 — 13	12½	...
400,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	106 —109	106 —109	108¾	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	7 %	...	6 — 6½	6 — 6½	...	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	6 — 6½	6 — 6⅛	6 1/16	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	105 —108	106 —109	...	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	11%	12%	10%	11 — 12	10½— 11½	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104	101 —104	...	...
110,600	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1½— 1⅝	1½— 1⅝	1½	...
49,840	Do. do. do. do. 6 % Pref.	5	...	...	...	4 — 5	4 — 5	...	...
250,000£	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	95 —100	95 —100	...	...
98,769	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	...	1⅛— 16½	15 — 16	15⅝	15 9/16
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	111 —115	111 —115	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	98 —101	98 —101	99½	...
8,652	Notting Hill Electric Lighting	10	7 %	7 %	...	15 — 16	15 — 16	...	...
40,800	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16 xd	14½— 15½	15	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9 xd	8 — 9	...	...
150,000£	Do. do. 3½ % Deb. Stock Red.	100	...	...	...	98 —101	98 —101	100	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	1⅞— 2¼	1⅞— 2¼	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90 xd	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
109,518	Westminster Electric Supply, Ord.	5	13 %	10½%	10½%	12 — 13	12 — 13	...	...

* Subject to Founders Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
§ Dividends paid in deferred share warrants, profits being used as capital.
¿Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotation Feb. 19th.	Closing Quotation Feb. 26th.	Business done week ended Feb. 26th, 1902. Highest.	Lowest.
20,000	British Aluminium 7 % Cum. Pref.	† 10	...	...	...	4½ — 5½	4½ — 5½	4⅞	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	88 — 92	88 — 92	...	...
62,074	British Electric Traction	10	8 %	9 %	...	14 — 15	13½ — 14	14½	14
90,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12¼ — 12⅜	12¼ — 12⅜	12⅝	12⅜
600,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	126 —129	...	...
70,000	British Insulated Wire Ord.	5	20 %	15 %	...	9½ — 10½	9½ — 10½	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅝ — 6¼	5⅝ — 6¼	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	8 %	...	⅞ — 1	⅞ — 1	...	...
50,000	¶ " " " 6 % Cum. Pref. ...	£1	...	6 %	...	20s. to 21s.	20s. to 21s.	...	...
105,731	Brush Elecl. Engng., Ord., 1 to 105,731	2	5½ %	5 %	...	1⅜ — 1⅝	1⅜ — 1⅝	1 9/16	1 7/16
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	...	2 — 2¼	2 — 2¼	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	102 —105	102 —105	...	...
125,000*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	97 —100	97 —100	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	16½ — 17½	17 — 18	17 13/16	17
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½ — 6	5½ — 6	5⅝	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	111 —115	111 —115	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	4 %	103 —106 xd	103 —106	104⅞	103⅛
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	4 %	103 —106 xd	103 —106	105½	...
440,100	Do. do. Def. do.	Stock	...	...	4 %	101 —104 xd	100 —103	101¾	...
855,000	City and South London Railway	Stock	1⅞%	1¼%	2 %	65 — 68	65 — 68	68	67
47,500	Do. do. Ord. shares Nos. 22,501 to 70,000	10	...	...	...	6 — 6½	6½ — 6⅝	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	7½%	8 %	...	3 — 3½	3 — 3½	3 5/16	...
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —104	99 —104	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	2½%	...	⅛ — ⅜	⅛ — ⅜	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	2½%	...	2 — 3	2 — 3	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	78 — 83	78 — 83	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	83 — 88	83 — 88	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1½ — 2	1⅝ — 1⅞	...	...
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390... ...	2	...	...	...	2½ — 3	2½ — 3	...	...
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	97 —101	97 —101	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9¾ — 10¼	9¾ —10¼	...	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	99 — 102	99 —102	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	15 %	20 %	20 %	18 — 19	18 — 19	18½	18
35,000	Do. do. do. 4½ % Pref.	5	4½%	4½%	...	5½ — 6	5½ — 6	5⅝	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	112 —116	112 —116	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	...	...
800,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	100 —103	100 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3⅛%	3¼%	1½%	5 1/16 — 5 3/16	4⅞ — 5⅛	...	...
10,000	† Do. do. Pref., £10 paid	10	5	...	...	11 — 11½	11 — 11½	...	...
7,500	Parker (Thomas), Limited, Ord., Nos. 1 to 7,500	10	...	...	...	15½ —16½	15½ — 16½	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	6 %	...	19/- to 20/-	... — ...	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	17½%	20 %	37 — 40	37 — 40	...	...
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	... %	...	...	102 —104	102 —104	...	...
25,000	Telegraph Manufacturing, Ord. Nos. 1 to 25,000	5	12 %	12 %	...	10½ — 11½	10½ — 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½ — 6	5½ — 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	91 — 94 xd	91 — 92	93½	91½

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 11/16—¾.
National Electric Free Wiring, 11/16—¾.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14½—15.
Do. do. Pref. (£10 pd.), 10⅜—10½.

* From Birmingham Share List. ¶ From Manchester Share List.

Bank rate of discount 3 per cent. (February 6th, 1902).

MARKET QUOTATIONS, Wednesday, February 26th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a " Nitric	per cwt.	22/-	22/-	..
a " Oxalic	per cwt.	32/-	32/-	..
a " Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a " " ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£18	£18	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a " (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£19 10	£20 10	£1 dec.
a Lead, Nitrate	per ton	£24	£24	..
a " White Sugar	per ton	£31	£31	..
a " Peroxide	per ton	£37 10	£37 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8d.	8d.	..
a " Caustic (76/80%) ..	per ton	£24	£24	..
a " Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	127/-	127/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	£6 5	..
a " Recovered	per ton	£5 10	£5 10	..
a " Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a " Crystals	per ton	£3	£3	..
a " Bichromate, casks ..	per lb.	2¼d.	2¼d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b " Wire, in ton lots	per ton	£224	£224	..
b " Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £125	£75 to £125	..
c Brass (rolled metal 7" to 12") basis	per lb.	6¾d.	6¾d.	½d. inc.
c Tube (brazed)	per lb.	8½d.	8d.	½d. inc.
c " " (solid drawn) ..	per lb.	7d.	6¾d.	¼d. inc.
c " Wire, basis	per lb.	7d.	7d.	..
c Copper Tubes (brazed) ..	per lb.	8¾d.	8¼d.	½d. inc.
c " " (solid drawn) ..	per lb.	9d.	8¾d.	¼d. inc.
g Copper Bars (best selected) ..	per ton	£71	£71	..
g Copper Sheet	per ton	£71	£71	..
g " Rod	per ton	£71	£71	..
e " Electrolytic) Bars ..	per ton	£63	£63	..
e " " Sheets ..	per ton	£75	£75	..
e " " Rod ..	per ton	£68	£68	..
e " " H.C. Wire	per lb.	8¼d.	8¼d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f " Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/- to 3/2	3/1 to 3/2	dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i " Pig (Cleveland warrants) ..	per ton	48/-	47/10	2d. inc.
i " Forgings, according to size	per ton	From £11	From £11	..
i " Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i " Wire, galvanised No. 8 ..	per ton	£9 5	£9 5	..
g Lead, English Ingot	per ton	£12	£12 2 6 to £12 5	2s. 6d. to 5s. dec.
g " " Sheet	per ton	..	£13 10	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 15	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d " " " medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large ..	per lb.	8/8 to 7/8	8/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	11¼d. to 1/2	11¼d. to 1/2	..
p " rolled bars & rods	per lb.	1/- to 1/3	1/- to 1/3	..
p " " strip & sheet	per lb.	From 1/2	From 1/2	..
c Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	10d. to 1/-	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i " " in bars		£58	£58	..
g Tin, block	per ton	£117 to £117 10	£118 10 to £119 10	30s. to £2 dec.
g " foil	per lb.	1/6	1/6	..
n " wire, Nos. 1 to 15	per lb.	1/6½	1/6	½d. inc.
p White Anti-friction Metals —				
"White Ant" brand	per ton	£35 to £65	£35 to £60	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j " 6 lea. Flax	per lb.	5½d.	5½d.	..
j " 3 ply 10 lbs. Russian ..	per lb.	4¾d.	4¾d.	..
j " 16 lbs. Russian, single ..	per lb.	4¾d.	4¾d.	..
j " 120 lbs. Jute rove	per ton	£10 2 6	£10 2 6	..
k Zinc, Sh't. (Vielle Montagne bnd.)	per ton	£22 10	£22	10s. inc.

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd c Messrs. Thos. Bolton & Sons, d Messrs. F. Wiggins & Sons, e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.-P. and Teleg. Works g Messrs. James & Shakspeare, (Co., Ltd. h Messrs. Edward Till & Co. i Messrs. Bolling & Lowe. j Messrs. Walter H. Hindley & Co.

Quotations supplied by { k Messrs. Morris Ashby, Limited. m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd p The Phosphor Bronze Company, Ltd.

VIBRATION ON THE CENTRAL LONDON RAILWAY.

The following extracts from the report of Lord Rayleigh's Committee on Vibration will be of interest to our readers:—

"The witnesses all deposed as to the annoyance caused by the vibration experienced by them, and they were of opinion that the shaking of which they complained was felt most severely when the trains first began to run in the morning, again between 5 p.m. and 8 p.m., and the last thing before the traffic stopped at night. This they attributed to the trains being more heavily loaded at such times, an opinion which was not supported by the scientific evidence subsequently obtained by the Committee, and they were nearly unanimous in stating that at times exceptionally severe vibrations occurred for which no reason could be assigned. . . .

"As a first step, the Committee satisfied themselves by personal observation that vibration sufficient to cause serious annoyance is actually felt in many of the houses situated along the course of the railway. A very little experience further showed that the disturbances due to successive trains are very unequal. In order to ascertain whether the specially severe disturbances could be connected with particular trains, some elaborate observations were instituted in which 10 or 12 observers—many of them pupils of Prof. Ewing—were stationed in various houses, and recorded during the whole of one day the times of passage of the trains and the estimated intensity of the vibrations. A comparison of these records with records made at the stations by other observers of the precise times of starting and arrival of the various trains gave the means of answering the question proposed. The results, analysed by Mr. A. Mallock, who was employed by us for the purpose of conducting the details of our investigation, showed (*a*) that it was a matter of chance whether a given train caused a slight or a severe vibration; (*b*) that trains causing a severe vibration in one house were as likely as not to cause only slight vibration in the others; (*c*) that different rooms in the same house were not similarly affected by the same train.

"In addition, Mr. Mallock, who had previously, in connection with some observations on vibration caused by the running of an experimental electrical train on the joint lines of the Metropolitan and Metropolitan District Railway Companies in 1899, devised suitable instruments for the purpose, made on behalf of the Committee a careful study of the nature and extent of the vibration both on the Central London Railway and in adjoining premises, and for the sake of comparison made similar observations on the Waterloo and City Railway, the Metropolitan Railway, and a portion of the Great Western Railway where bridge rails similar to those used on the Central London Railway are laid down. . . .

"One of the most distinct indications from Mr. Mallock's records was the responsibility of the locomotives, as distinguished from the carriages, for the worst part of the disturbances, and the attention of the Committee was called at an early stage to the excessively large load, unrelieved by springs, carried on each axle of the locomotives. The unspring-borne load carried on each of the four axles of the locomotive is 8 tons, making 32 tons in all. This construction was adopted in order to obviate the necessity for gearing, and the Committee could not but connect the difficulty with the magnitude of this unspring-borne load. This view was in entire accordance with the results of the experiments on the Metropolitan and Metropolitan District Railways to which we have already referred. . . .

"The Committee were also anxious to examine the effect of a stiffer rail on the Central London Railway itself. But although a short length would have sufficed, and the company did all that was in their power, the experiment could not be carried out. The present rail is of the "bridge" pattern, and room could not be found for the greater depth necessary to attain increased stiffness without encroaching too much upon the already narrow margin allowed between the tunnels and the tops of carriages. In the opinion of the Committee it is unfortunate that so small a margin was provided. According to Mr. Mallock's observations of the air pressure in front of the trains, the power required to propel them is much increased by the closeness of the fit, so that there would have been compensation in this direction for some increased cost in constructing larger tunnels.

"As to the cause of the vibration, the problem here differs materially from one with which it is sometimes confused, *i.e.*, the explanation of the tremors propagated from fast running and imperfectly balanced machinery. In the present case there are no reciprocating parts, and the revolving parts are perfectly balanced. Moreover, the weight borne on the axles of the locomotives, even though unrelieved by springs, will not of itself account for the objectionable vibration. If the tires were perfectly circular, and the rails in their natural condition were perfectly straight, and were so supported as to yield everywhere equally to the load as it passed, there would be nothing to cause vibration. When rails are supported on transverse sleepers, vibrations corresponding to the distance between the sleepers are to be expected, and may in some cases be traced; but on the Central London Railway the sleepers are longitudinal. It was thought at first that the rail joints, which must almost inevitably introduce a varying yield, and which do, in fact, cause a good deal of noise, would prove to be an important source of vibration, but Mr. Mallock's records do not bear out this anticipation. Another want of uniformity of support, probably operative to some extent, is due to the flanges by which the lengths of tube are connected. Where the sleeper crosses the flanges, the yielding under load is presumably less than at intermediate places.

"From measurements made by Mr. Mallock there is reason to believe that the principal source of disturbance lies in the unevenness of the surface of the rails. As they leave the rolls the rails are usually curved, and the process of straightening by local bending beyond the elastic limit, however skilfully carried out, inevitably leaves a certain waviness. As the unspring-borne part of the load follows the rail over the crests and hollows of the waves, it is subject to vertical accelerations which cause the pressure on the support to become variable. When there are no springs, and the speed is high, a state of things is soon reached in which the pressure on the rail momentarily disappears and the load is on the point of jumping across the hollows. Such part of the load as is carried by suitable springs moves nearly in a horizontal line without following the waviness of the rails, and the pressure on the rails corresponding to it remains nearly uniform and accordingly innocuous. When very high speeds are contemplated it may become a question whether a higher standard in respect to straightness should not be aimed at.

"It appears that the irregular impulses given by uneven rail surfaces have the effect of establishing and maintaining an oscillation of the rails and road bed, the whole being regarded as an elastic support loaded with those masses which are not carried by springs. This view is borne out by the observed fact that the chief oscillations, as recorded in the tunnels, were found to have about the same frequency when the train producing them was run at various speeds.

"The new locomotives were ready for trial in August, and were of two types. In one the locomotive is, as before, distinct from the passenger cars, but gearing is introduced, so that the electric machinery is no longer mounted directly upon the driving axles. The unspring-borne load is correspondingly reduced, and amounts to 2½ tons on each axle, as against 8 tons on each axle of the old locomotives. This type, of which there are three specimens, is described as the 'geared' locomotive.

"In the other system, known as the 'multiple unit, or motor-car system, the locomotive is not distinct, but motors are carried at one end of two or more passenger cars. In this case the unspring-borne load on each axle of the truck under the motor is 1¾ tons Some further particulars are set out in the annexed table.

Weights per Axle on the Various Classes of Rolling Stock Referred to in the Report.

Description of rolling stock.	Weight per axle in tons.		
	Spring-borne.	Unspring-borne.	Total.
Gearless locomotive (total weight, 44 tons)	3	8	11
Geared locomotive (total weight, 33 tons)	5·75	2·5	8·25
Multiple-unit train (total weight of motor carriage, 20 tons)—			
Motor axles	4·75	1·75	6·5
Other axles	2·4	1·1	3·5
Passenger coaches (total weight, 14 tons)	2·4	1·1	3·5

"Observations in the tunnels made by Mr. Mallock for the Committee showed, as had been expected, a great improvement. The vibrations in the ground decreased in proportion to the unspring-borne load; for the geared locomotive they were less than one-third, and for the motor-car train less than one-fifth, of what were caused by the ordinary locomotives. Like results were observed in some houses which we had previously visited.

"These observations are set forth in the appendices to the report; but we were naturally desirous of making personal comparison of the disturbances due to the various types. In order to identify the trains, it is almost a necessity to connect by telephone the house in which observers are placed with the signal boxes at the neighbouring stations. Signals can thus be sent at the moment when a train begins to move, and after an interval, which is nearly the same for trains travelling in the same direction, any disturbance caused by the train in question will be due at the house. We are indebted to Mr. Hoghton, of 13, Hyde Park Terrace, and to Mr. Pike, of 4A, Marlborough Gate, for allowing telephones to be fitted in their houses, and for giving the Committee opportunities for meeting there to make the necessary observations.

"The first observations of this kind were made at Mr. Hoghton's house on November 28th. During some two hours every train either way drawn by an ordinary locomotive—gearless—was distinctly felt, while of the trains drawn by geared locomotives or by motor carriages not one was felt. The result was eminently satisfactory so far as it went; but we were desirous if possible of distinguishing the effects of the two new types, and it was for this purpose that further observations were made at Mr. Pike's house, where former experience had shown the disturbances to be very intense. The difference between the old and the new types was maintained, but it became possible to discriminate to some extent between the two new types. The passages of the geared locomotives were felt slightly in several cases, but in no case was the motor car train perceived.

"In view of these results we have no hesitation in recommending the adoption of a type of locomotive or motor in which the load not carried on springs is reduced as far as possible. This may be arrived at by using gearing as in the geared locomotives or motor

carriages, or by using a gearless locomotive, in which an elastic connection is employed between the driving-axle and the motor; but we have had no opportunity of experimenting with a locomotive of this type.

"In the trials which have been carried out the motor cars were found to have an advantage in freedom from vibration over the geared locomotive. So far as the Central London Railway is concerned, we are confident that by adopting motor cars in place of the original locomotives the vibration produced by the running of trains can be reduced so as to cause no serious annoyance, although it is possible that the sound of the trains may still be detected, especially in the night. We are able to speak positively as to the motor cars; but we have little doubt that any method of driving in which the unspring-borne load on each axle is reduced to a similarly small quantity might also be used with impunity.

"On the question of the best form of rail and sleeper we have no decisive evidence. We are disposed to prefer a stiffer rail than that in use on the Central London Railway, and we think that in new undertakings sufficient room should be allowed for the introduction of a deeper rail; but we are of opinion that, without altering the permanent way of the Central London Railway, the change of motors which we have recommended will effect a practically complete cure of the disturbances complained of.

"In conclusion, we desire to express our thanks to the officials of the Central London Railway and other railways for the uniformly courteous and zealous manner in which they have received our suggestions for experiment, and for help in carrying them out. To Mr. Mallock's scientific insight and perseverance such success as we have been able to attain in the elucidation of a difficult problem is largely due, and in the appendices contributed by him to the report will be found valuable material for the guidance of future inquirers in this field."

EVAPORATIVE SURFACE CONDENSERS.

A few figures of interest appear in Mr. H. G. Oldham's paper in *Feilden's Magazine* on "Evaporative Surface Condensers," though we can hardly endorse the statement that only recently have steam users become alive to the large saving that may be effected by condensing. We might correct this by saying that only recently is it that steam users have shown their ignorance of the saving to be made, and, unfortunately, objections to condensing have come from those who should know better. Otherwise, how is it that one sees so many electrical plants devoid of condensing facilities, and, where such facilities exist, how is it that so little care is taken to render the plant efficient by means of air-tight joints?

The evaporative condenser is the answer to the stock argument that "we have not water sufficient to condense with." This lame excuse is met by the reply that for each pound of steam condensed that would otherwise be thrown into the air and lost, only three-quarters of a pound of water will be evaporated on the outside of the tubes. Thus, by condensing, at least 25 per cent. of the water may be economised, not to name the further economy which results from the reduction of the steam used by a condensing, as compared with a high-pressure engine. There is a double saving, and as the economy due to condensing may reach even 40 per cent., the actual feed water required may be reduced in cases to one half. Of course, an atmospheric condenser can be made to work without the wetting of its exterior if only it is large enough, and without water Mr. W. G. Walker has stated he obtained 2 lbs. condensation per sq. ft. of tube surface per hour when passing air over the tube surface at a velocity of 1,000 ft. per second (? probably per minute is intended). About 2,400 cub. ft. of air would be required for each 1 lb. of steam; thus, for 100 H.P. at 20 lbs. of steam per horse-power hour, there would be required 1,000 ft. of surface and 80,000 cub. ft. of air per minute. Mr. Longridge found that 2,000 sq. ft. dealt with 60 to 80 I.H.P. at 25 lbs. of steam per I.H.P.-hour without water, and he said that without a fan a condenser would work well if it had 125 sq. ft. of surface for each pound of steam per minute, but this is quadruple the area found by Mr. Walker when a fan was used to move the air, namely, 30 sq. ft. per 1 lb. per minute.

Thus, where no water supply is convenient, condensing may be effected in dry condensers of about six fold the external surface necessary where water is available. The larger the area of condenser the less is the water loss, for more heat is lost to the air. The author describes various condensers, and shows how tubes are arranged to receive a film of water over their surfaces.

When pipes are made of thin copper they are very efficient, and they are self-cleansing from the scale which deposits out of the cooling water owing to their difference of expansion which cracks off the scale.

In a Ledward condenser, tubes of 5 in. diameter are disposed to give 11,800 sq. ft. of area, and 30,000 gallons of water per hour is circulated over this surface, and condenses 26,000 lbs. of steam. When condensing 20,000 lbs. of steam per hour the vacuum was 26 in. It is hardly necessary to say that so great an extent of surface probably implies many tube joints, and care is demanded that all joints should be airtight, or but a poor vacuum will be secured. The author suggests separators for the purpose of cleansing the exhaust steam of oil. Our opinion is that, as he says, the separator is superior to filtration. Separators are very efficient in removing oil from exhaust steam.

THE DESTRUCTIVE AND LETHAL EFFECTS OF HIGH-PRESSURE* CURRENTS.†

By Dr. MARGARET A. CLEAVES.

(*Concluded from page* 316.)

Resuscitation.—As to resuscitation after electric shock, an analysis of the work of the different experimenters instanced in this paper points very clearly to the inefficiency of artificial respiration when there has been a purposed application of a lethal current; and an analysis of the accidents occurring from electric currents points to the same conclusion.

D'Arsonval, in 1887, and later in 1894, voiced the opinion that after an electric shock the individual should be treated by means of artificial respiration, as in the case of the drowned, "since the condition after the shock is one of suspended animation, in which the respiratory function is suspended."

In the light of the experiments quoted in this paper, such a procedure can be regarded only as unphysiological and ineffective. It has been pointed out that in rare instances in which the current for a long time passed through the brain and upper part of the spinal cord, but where the heart does not lie in the conducting path, artificial respiration might be of avail. In accidents in which there is but a momentary contact with a current of high pressure artificial respiration is always indicated. But when the current has exerted its power mainly upon the heart and the latter has ceased to beat, artificial respiration will do no harm, but we can scarcely expect that it will do any good. Finally, in those cases in which there has been an actual mechanical and disruptive action, death is absolute and artificial respiration valueless.

It has been shown that after a brief application of an electric current to the exposed heart of a dog, a brief period of fibrillation may be followed by the reappearance of a few co-ordinated heart beats (Herbst and McWilliams). "Should this occur," says Cunningham, "before the general blood pressure has become greatly diminished, it is possible that the disturbed circulation might be restored. Once, however, it has fallen to zero the right heart becomes so over-distended with venous blood, which may coagulate in a few moments, that even though one or more feeble, co-ordinated beats occur, the overfilled right heart cannot empty itself with sufficient rapidity through the lungs so that the left ventricle can produce enough pressure in the aorta for the necessary blood to be forced through the coronary circulation rapidly enough for the spontaneously restored co-ordinate contractions to be maintained."

In those cases in which artificial respiration is indicated, inhibition of the respiratory centre (Laborde's method), which Laborde called the physiological treatment of death (*i.e.*, rhythmic traction of the tongue), should be practised.

When the action of the electrical current has been upon the heart, the indication is to restore the circulation—not only of the nervous system, but also of the heart—as quickly as possible, in order that the latter may quickly recover its co-ordinated contractions. There is but one way in which this may possibly be accomplished, viz., by the establishment of a temporary circulation of a fluid which will feed the heart and nervous system until the former has sufficiently recovered to perform its function. "Of all the various fluids recommended for intravascular injection, the defibrinated blood from another animal of the same species is the only one capable of maintaining the circulation. The mere arterial injection of warm, defibrinated blood would not answer, for the injected blood, after passing through the capillaries, accumulates in the venous system and in the distended right heart until finally the veins rupture or the general vascular pressure equals the pressure of the blood being injected. The over-distention of the heart prevents the re-establishment of the coronary circulation, an element of greater importance in establishing the co-ordinated heart beat.

"This enormous increase in the pressure could be prevented only by the establishment of an outlet in the right ventricle for the injected defibrinated blood. With such an outlet the oxygenated blood would circulate through the coronary arteries and the nervous system, but naturally there would be no pulmonary circulation. Under these circumstances artificial respiration would be of no avail, save possibly to assist the outflow from the heart."

Owing to these very serious obstacles, the matter of resuscitating the heart's action by perfusion of defibrinated blood becomes at once absolutely impracticable. The solution of the problem as a mere laboratory experiment is a totally different matter.‡

The observation of the fact that the employment of oscillatory currents of high potential favours the recovery of a fibrillating dog's heart, and of the results obtained by the use of such currents in therapeutic work, suggests the possibility that a similarly favourable effect may be produced in the human being in cases in which the heart has not been too profoundly affected. Experimental work in this direction could not fail to be of value, no matter what might be the conclusion reached. Further experimental researches into

* In every instance in which authorities quoted have used the word "tension" in relation to an electric current, the writer has substituted "pressure," in order that the terminology may be exact.

† *Handbook of the Medical Sciences. (U.S.A.)*

‡ For a detailed account of the apparatus to be used in the laboratory for the recovery of animals the subject of experiment, see Cunningham's article, New York *Medical Journal*, October 21st and 28th, 1899.

Reference.	Circumstances.	Current.	Symptoms.	Result.	Post-mortem findings.	Treatment.
1. R. W. Pope: New York *Sun*, October 14th, 1895.	Accidental contact with wire in cellar of residence; heard to fall; found dead.	2,100 volts, alternating from converter; leakage possible.	Not given; found dead.	Death.	Deep ragged scratch on right hand and electrical burn; other minor burns.	
2. New York *Sun*, January 22nd, 1896.	Faulty connections of wires. Current passed direct from dynamo to switch, omitting transformer; switch handle grasped.	2,000 volts, alternating.	Felt smarting pain in palm of right hand; no other pain for some minutes, then dizzy and fainted; soon recovered. Later spasms of pain in injured arm, running across breast to heart, which felt as if grasped in a vice. Red marks, shape and size of banana, under each ear; sensitive. On left arm, midway between shoulder and elbow, two irregular black and blue marks close together, 1 by ½ in. Around these flesh inflamed and puffed up. Spasms of pain, 40 at intervals of a few minutes; entire left side numb; blind 45 minutes; delirious some hours; later, for several hours, unable to speak.	Recovery.	.. ..	Morphine, brandy, sinapisms to præcordium.
3. D'Arsonval: Comptes rendus de l'Acad. des Sciences, 1894, p. 1139.	Man sat astride of bar connecting wires, telephone wire in hand which touched another conductor.	4,500 volts, 750 ma., frequency 55 periods per second, duration several minutes.	Apparent death. Lungs began to act almost at once after artificial respiration began; burn on right hand and buttock.	Recovery.	. .. .	Artificial respiration. Method of Laborde. After two hours, spoke.
4. Cardew: London ELECTRICAL REVIEW, March 15th, 1895.	Rubbing dust off high-pressure "terminal board." Neglect of rubber gloves.	2,000 volts, alternating.	Uttered loud cry; lost consciousness; remained standing leaning against the terminals.	Death.	Not given	Artificia respiration.
5. Kratter: London, *Lancet*, August 31st, 1895.	Workman stringing telegraph wires.	Not given.	Not given	Death.	21 hours after death. Ruptured blister on left forefinger. Marked rigor mortis; intense ecchymosis on dependent parts. Hypervenosity of blood; venous engorgement of lungs; blood extravasated into common sheath of carotid and vagus nerves on both sides. Symmetrical hemorrhages along spinal cord.	Not given.
6. Shield and Delphine: *Brit. Medical Journal*, 1895, Vol. i., p. 531.	Manipulation of electrical machine, accidental putting self in circuit.	Not given.	Not given. No alteration perceptible in texture of clothes nor in metallic substances on the person.	Death.	40 hours after death. Rigor mortis marked; great cutaneous congestion; on left index finger small blister; appearance of burn, but no redness around it; no charred smell; muscles of thorax firm and resistant to knife; internal viscera healthy; extreme fluidity of blood; heart uncontracted; fibres under microscope normal; microscopic examination of sections of region of blister showed marked differences from common burn. (Described in detail.)	Not given.
7. Clowes: London *Lancet*, December 17th, 1892.	Making connections with house for street current.	2,000 volts, alternating, 10,000 per minute, 166+ per second.	Fell to one side as in a fit; five minutes after, heart and respiration were stopped; surface congested; pupils dilated; features not distorted; smell like gas; palm and first two fingers of left hand burned; fingers flexed; clothing not burned.	Death.	Three days after death. Rigor mortis marked; decomposition not advanced; burns as described, deep and carbonised; epidermis of palmar surface burned black and separated; dorsal surface, epidermis destroyed in small circular spot; ecchymosis and swelling on right frontal eminence; vessels of scalp, meninges, brain, and brain substance congested and full of liquid blood; lateral sinuses full of blood; mucous membranes, larynx, trachea, and bronchi congested; lungs loaded with dark blood; heart not contracted, but cavities completely empty; deficiency of blood in large vessels; liver congested and dark red; spleen large and engorged with blood; kidneys large and congested; complete fluidity and dark colour of blood; not a clot found in body.	Artificial respiration for one hour, no response; strychnine hypodermically. Faradic current to præcordium.
8. New York *Herald*, May 31st, 1901.	Boy 9 years old, caught hold of electric light wire passing over roof; insulation insufficient.	10,000 volts.	Immediately swung off into the air; smoke arising from the wire at point of contact. Boy's hold not loosened until hands were pounded; body dropped apparently lifeless.	Recovery.	.. ..	After boy supposed to be dead, artifical respiration practised; semi-consciousness produced, continuing 24 hours or more (not definitely stated).
9. Kolben: *Electrical World and Engineer*, March 17th, 1900, vol. xxxv., No. 11, p. 411. *Elek. Zeit.*, Feb. 15th, 1900.	Workman in potash and alcohol plant stood on iron tank covered with soda lye of good conductivity; boots wrapped with rags of twilled linen; drunkard.	95 or 96 volts, alternating.	.. ..	Death.		
10. W. S. Hedley: London *Lancet*, December 5th, 1896.	Casually placed hand on metal corner of ammeter, and, turning, placed other hand on iron pillar. Ammeter case in accidental metallic contact with light leads and return wire was earthed by contact with iron post.	2,500 volts, alternating.	Found himself standing on the floor, forearm drawn up to chest, hands clenched; from above elbow downward described feeling of pulsation and violent beating in synchronism with alternations (83 periods per second); power of movement below elbow lost, but arm at shoulder could be moved; pulsation soon became less violent and motor power returned successively in the muscles of forearm, wrist, and fingers. In three minutes completely restored. No sensation of burning at the time, but in ten minutes hands became painful and examination revealed burn on tip of left middle and ring fingers, with scarred line across lower portion of palm. Since accident. claims to feel better in general health.	Recovery.		

Reference.	Circumstances.	Current.	Symptoms.	Result.	Post-mortem findings.	Treatment.
11. London ELEC. REV., February 23rd, 1900.	Assistant in electric light station accidentally put hand on spring on switchboard. No insulation on floor.	3,000 volts alternating.	Instantaneous death	Death.	Cauterized wound on knuckle of left forefinger. Heart empty of blood; several small blood vessels shattered.	
12. London ELEC. REV., June 15th, 1900.	Victim found dead with wire grasped in left hand, which was used to draw arc lamp up and down; leakage to wire.	700 volts direct current.	Instantaneous death	Death.		
13. London ELEC. REV., August 6th, 1897.	Employé at electric light station.	Not given.	Instantaneous death	Death.	Not stated	Artifical respiration one hour.
14. London ELEC. REV., June 3rd, 1898.	Employé at electric light station, switched off transformer without gloves.	2,000 volts high-pressure, continuous current.	Instantaneous death	Death.	Thumb of right hand with portion of joint burned off; tracing up arm where electricity ran; skin peeled off	
15. London ELEC. REV., September 2nd, 1898. From *Cape Times*, August 8th, 1898.	Wireman working in transformer chamber caught hold of fuse handle; was removing some temporary electrical apparatus which had been used at a ball at Government House; rubber mat and rubber gloves within reach but not used.	1,500 v ts.	Spoke after shock but died immediately.	Death.	Left heart empty; blood did not coagulate. Rigor mortis strong after 19 hours. Brain and other organs congested.	None.
16. London ELEC. REV, October 21st, 1898.	Electric wireman fell across terminals of one of the machines in electric supply station; was crossing wires leading to a switchboard.	1,000 volts.	Found dead in semi-reclining position	Death.	Not given.	
17. London ELEC. REV., July 24th, 1896.	Sub-foreman at electric light station; neglect of rubber gloves in making a connection.	Not stated.	Instantaneous death	Death.	Burn between thumb and index finger of left hand.	Artificial respiration. Time not given.
18. London ELEC. REV., January 6th, 1899.	Workman making temporary point on high pressure cable.	2,000 volts.	.. ..	Death.	.. ..	Artificial respiration.
19. London ELEC. REV., January 27th, 1899.	Accidental contact with wires of arc lamp circuit.	4,000 to 5,000 volts.	Fell immediately but rose, took three or four steps, and sank unconscious.	Death.	.. ..	Artificial respiration. Died on removal to a place of shelter. Time not stated.
20. London ELEC. REV., September 20th, 1898. *L'Industrie Electrique.*	A beam fell upon wires carrying them down upon workman, who was killed. The other workmen who went to his assistance were killed.	2,400 volts, alternating current.	Instantaneous death in the three cases.	Death.		
21. *Revue Scientifique*, May 18th, 1901. (Variétiés.) ("Souvenirs d'un Electrocuté.")	Grasped two large electrodes; current passed two or three seconds before turned off.	Secondary current from a Ruhmkorff coil, excited by alternating current, 110 volts, 42 periods per second, about 20 ms., primary current 50 amperes.	No burn. Thrown to the ground by general muscular tetanus; could not cry out; lost sensation of upper limbs and trunk; perturbation of vertical and colour sense; unconscious a few seconds; no pain. On trying to move arms and hands found them paralysed. Hyperæsthesia to cold; loss of tactile sensibility and muscular sense; hyperæmia of hands and forearms. In three to four minutes arms recovered mobility; 15 minutes hands the same; some hours after interossei recovered. Same time, three to 15 minutes, tactile sense and muscular sense recovered. Heat sense returned to normal half-an-hour later. At this time on trying to walk out of breath. One hour and a half after, tachycardia, arrhythmia, continuing until next day; stopped suddenly. Lassitude lasted 36 hours.	Recovery.		

the mechanism of death are also desirable. However, if we are to obtain further knowledge as to when an attempt at resuscitation is likely to prove successful, we must not only extend our experimental researches, but we must also observe with greater care and with more scientific accuracy the phenomena resulting from accidental contact with industrial currents, and we must study more closely the post-mortem conditions. It is also desirable that accurate observations and records should be made of all the conditions of the conducting circuit, of the character and pressure of the current, of the current strength or amperes, of the position and nature of the contacts, and also of the duration of the contact. Such accumulated evidence should be of value in establishing the fact of death and determining its mechanism, or in indicating, in cases of apparent death, the phenomena which warrant the hope that efforts at resuscitation will prove successful.

The accompanying table of accidents from electric currents has been largely made up from cases described in medical and electrical journals. In all accounts of accidents, whether mortal or not, the data given have been found to be very meagre, and the table, though very incomplete, is as full and exact as the data furnished would admit of. There is also in both medical and electrical literature a striking dearth of detailed cases and even of any mention of accidents, which leads to the assumption that they are comparatively rare.

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WIRELESS TELEGRAPHY AND SUBMARINE CABLES.

By EMILE GUARINI.

PEOPLE have made, are making, and will continue to make for some time yet, various criticisms upon, and objections to, trans-Atlantic wireless telegraphy, or, to speak more generally, to trans-oceanic wireless telegraphy.

These criticisms and objections come under three very distinct headings, which must not be confounded in any way, *i.e.*:—

1. The possibility of trans-oceanic wireless telegraphy.
2. The technical side of the question.
3. The commercial side of the question.

As to the possibility of trans-Atlantic or trans-oceanic wireless telegraphy, we can already feel assured of it. Many of the sceptics who did not believe in this possibility—were there not people about half a century ago who did not believe in the possibility of laying the Atlantic cable, now quite an everyday occurrence—believe in it now?

But there are others who do not yet believe in this possibility. Why not? If they did, they would take care not to say so, and with good reason. As a rule, any invention that seems likely to upset the existing order of things meets with three kinds of opponents:—

1. Systematic opponents, who are unfortunately numerous. Th y never give in, for when it has been shown them unmistakably that what they thought impossible has really been done, they raise fresh objections, and bring forward something—impossible to them—that has not yet been done; can everything be done at once?

2. Great *savants* and the ignorant: the former understand too much, the latter understand nothing at all—so much the better for them!

3. Those to whose interest it is not to understand.

One thing, however, can console us: there always have been—and probably there always will be—objectors of this class. Besides, is it not better that it should be so? Does not discussion make the truth shine out more clearly, and does not what is bad make what is good stand out more distinctly?

We are not now going to consider—we shall return to this point later—whether in going from Lizard Point to St. John's, Newfoundland, the electro-magnetic waves are propagated from below, from above, or through the sea water, or whether the effect is due to a diffraction (in which case the waves must have surmounted an obstacle of 225 km.).

For those, therefore, who still decline to believe in the possibility of trans-oceanic wireless telegraphy, we have only one argument to bring forward. At the beginning of wireless telegraphy, when the distance between the two communicating stations was only a few kilometres (5 km.), the distance of 300 km. (a distance undoubtedly attained between Lizard Point and St. Catherine's Point, Isle of Wight) would no doubt have seemed something extraordinary, but it would have been rash to say, as some did say, that wireless telegraphy through the air would *never* accomplish such a distance.

It is a great mistake to try to judge the future of a new invention by what it is, and not by what it may become, with the aid of successive improvements. We have only to recall the great difficulties, with regard to its applications as much as to its technical development, encountered at the commencement by ordinary telegraphy, in order to convince ourselves of the truth of what we have just asserted.

Now a distance of 300 km., in comparison with a distance of 5 km., is much greater than 3,350 km. (the distance from Lizard's Point to St. John's, Newfoundland) in comparison with 300 km. (a distance which, as we have already said, has undoubtedly been attained, at sea, be it understood). In short, the ratio of 300 (the distance that was being attempted seven years ago) to 5 (the distance attained in 1895 by Marconi at Bologna) is 60, whereas the ratio of 3,350 (the distance in question now) to 300 (the distance attained up to now) is only 11, *i.e.*, about one-sixth of the first ratio. We may therefore conclude that if wireless telegraphy has already made an advance with respect to distance equal to 60 times what had already been achieved, it can certainly be expected to accomplish a distance 11 times as great as in previous attempts.

The criticisms and objections relating to the technical side of the question are:—(1) The installations are affected by bad weather; (2) the speed of transmission is not very great; (3) a large amount of energy is required, whereas in ordinary telegraphy a small amount is sufficient; (4) there is no secrecy with regard to the despatches; (5) the communications can be interfered with and rendered unintelligible; (6) the atmospheric electricity has a disastrous effect upon the system. Fortunately, the objections stop here. It would be out of place to discuss here the opinion of various experts—really competent men moreover—who have asserted that if wireless electric telegraphy had preceded the ordinary telegraphy, the latter would have been considered an advance upon the former.

This is a theorem which has yet to be demonstrated. While we are waiting for this demonstration—which will perhaps never arrive—we may say at once that if there is any comparison to be made between submarine cables and wireless telegraphy, the latter must be considered from the point of view of what it will be, what it is capable of becoming, and not from the point of view of what it is now. Otherwise, no comparison would be possible, for the simple and good reason that the cable industry is one which has been brought to a high degree of perfection, whereas wireless telegraphy is in its childhood, a new industry, and therefore one capable of improvement.

It is true, to a certain extent, that wireless telegraphy installations are affected by changes in the weather. If, for instance, we used as formidable an installation as that established by Marconi at Lizard Point, which we know has on several occasions been damaged by wind, this objection would be justified. But it must not be forgotten that this was only a provisional installation made for the purpose of ascertaining what was necessary for trans-Atlantic communication. Who can say that soon a small radiator suitably fixed and worked will not suffice to transmit the energy required to influence, and possibly to work, a receiver at New York and *vice versâ*. Are not the practical and commercial installations of the present day (for wireless telegraphy) much more simple than those of three years ago? Thus we see—to give one example—that whereas the regulation of the stations was effected by broad metal bands placed on each side of the antenna in the experiments of 1899 across the Channel, it is now done by means of the condensers and self-induction coils in the station itself. This is, of course, a great step in advance. Moreover, it must not be forgotten that cables are subjected to many injurious influences which can only be avoided to a very limited extent, which is clearly shown by the fact that every week the electrical journals in England, for instance, give a long list of interrupted services. In fact, the cable is subject to deterioration caused by:—

1. Rubbing on the rocks and stones at the bottom of the sea, suspension over a submarine valley, insufficient slackness of the cable during submersion, damage caused by icebergs coming from the poles, volcanic eruptions, and submarine subsidences.

2. Anchors cast accidentally on the path of a cable, and by fishing and coral-fishing apparatus.

3. Submarine animals, some of which, such as the teredos, the xylophagi, and the limnoria, eat into the core of the cable or its protecting envelopes, and others, such as sharks, sword-fish, and whales, come accidentally in contact with the cables.

4. Breakages in the conductor, and faults latent in the cable since its construction, and becoming apparent after a more or less protracted immersion.

In wireless telegraphy—as there is no wire—none of these disadvantages exist.

The question of speed of transmission we have treated in a former note (January 31st). Do not let us forget that at first the dynamo gave out only some hundredths of the energy employed, and that the trans-Atlantic submarine cable of 1858 only transmitted one word a minute, so that it took 30 hours to send President Buchanan's telegram, which was not an unusually long one.

With regard to duplex communication, we have been reminded—and justly—that the great advantage of this system consists in sending messages simultaneously in opposite directions. We have said that at present this is not possible with wireless telegraphy. But we will complete our reply. We have said that it is not yet possible because it has not yet been done, and not because it is impossible that it should be done.

What is really the problem to be solved? We have A and B, two stations, each provided with a transmitter and a receiver (we say one, but we might have said several); it is required that A shall transmit to B at the same time as B transmits to A. What is necessary in order to do this?

Merely that the receiver of each station shall not be influenced by the transmitter of the same station. Well, Marconi said during his conference at the Society of Arts on syntonic wireless telegraphy, May 15th, 1901, that "If a transmitter and a receiver differ very much in their periods, the receiver will only be influenced within 50 metres." Thus—it seems to me—the solution is easy. The transmitter at A is syntonised with the receiver B at accordance 1 and the receiver at A is syntonised with the transmitter at B at accordance 2. These two accordances differ greatly from one another. This being done, we have only to separate the receiver and transmitter at each station by a sufficient distance in order to get *duplex* communication as in ordinary telegraphy.

Another way (especially applicable when instead of one there are at each station several receivers and transmitters) is to keep the apparatus and the antennæ near to one another and use one of the protecting appliances described in my English patent (1,555—1900), or in the note which, jointly with Poncelet, I submitted to the Académie des Sciences, Paris, in September, 1900 (No. 13, pp. 540—541).

The question of energy (in Marconi's recent experiment it was probably 150 watts $\times \left(\frac{3,350}{300}\right)^2$ = about 25 H.P.) was fully discussed in my former note. I may here add two remarks:—(1) First comes the *fait accompli*—the achievement of trans-Atlantic wireless telegraphy, even if it had required 1,000 H.P.—the next consideration is simplifications and improvements. First the complex, then the simple. (2) The fact that the energy increases with the square of the distance only applies when curved surfaces are used as radiators. A plane surface gives parallel radiations (see M. Tommasina's photograph of the waves and my English patent No. 1,555—1900).

There are three methods of ensuring secrecy with regard to the dispatches:—(1) Syntonisation, which, however, only ensures it to a very limited extent; we shall see why presently; (2) *indirect* methods, such as those proposed by Messrs. Blondel, Tommasi, Tegon, &c.; (3) the directed wave, which, in my humble opinion, is *the only way* that solves satisfactorily the problem of *absolute* secrecy with regard to the dispatches and that of multi-communication in opposite directions (patent 1,555—1900). We shall go more into detail on this point in a subsequent note. The question of confusion of messages also enters into that of secrecy, for which reason we shall revert to it later.

Lastly, there remains the question of the influence of atmospheric electricity on the radio-conductors. This is a very interesting question, of capital importance in wireless telegraphy (through imperfect contacts rendered conductive under the influence of electro-magnetic waves), and as it is very much under discussion just now, and the opinions expressed are far from agreeing with one another, we will go into it a little further here, at the same time reserving it for a future occasion to go into the subject more in detail. When we speak of the effects of the atmospheric electricity on the radio-conductors, we must distinguish carefully between (1) Lightning; (2) Silent atmospheric electricity, or, in other words, the charge received by the antenna under the influence of the electricity with which the atmosphere is charged.

In the case of lightning, the effects must be classified as follows:—(1) Destructive effects; (2) Disturbances of the communications. The first part of the question, as stated by the Electrical Review in the editorial of January 1st, was discussed by Marconi at the Institution of Electrical Engineers, in March, 1899. We may add that nothing prevents us from using a lightning conductor at the top of the antenna, and insulated from it. It is, moreover, evident that lightning must act upon a receiver as on any other conductor. Lightning is not, however, so very frequent, and it possibly would not cause a greater derangement or interruption than is produced by storms on ordinary telegraph and telephone services. Moreover, one method of limiting the effects of lightning (for fixed stations at least) would be to surround the antennæ with suitable protecting sheaths. By virtue of the property of hollow conductors the receiver would then only be affected by flashes of lightning coming from the side where the sheath is open.

The effects of silent atmospheric electricity would be more disastrous—since more frequent—if suitable means were not employed to guard against its influence. There are various methods employed for this purpose, all more or less efficacious. Thus, for instance, we get better results if we use very short antennæ, if we avoid points, if we use coherers of mean sensibility (*i.e.*, having a higher critical tension than in coherers that are extra sensitive), and, lastly, if we use horizontal antennæ.

But the two most efficacious methods of guarding against the effects of silent atmospheric electricity consists either in connecting the antenna to earth, as Tesla, Marconi, and Slaby do (we will elsewhere indicate several modes of accomplishing the same purpose), or in *insulating* the coherer from the earth (in the case of direct connection between the coherer and the antenna). In this last case, as shown by personal experiments and by a note presented by Prof. Tommasina to the Académie des Sciences, Paris, December 9th, 1901, the coherer is no longer influenced by silent atmospheric electricity (with the exception of sudden variations of potential). This is easily explained. The coherer being insulated, its two terminals are almost at the same potential, whereas when it is connected to earth one of the two terminals is at zero potential, and the difference of potential between the terminal connected to earth and that connected with the antenna *may* be sufficient to affect the coherer, *i.e.*, it may be higher than the critical tension of the latter.

While we are waiting to be able to give a more ample demonstration of what we have just advanced, we may conclude that *the effects of atmospheric electricity on the wireless telegraphy receivers will not be more disastrous than they are in ordinary telegraphy.*

The commercial side of the question, the future, the possibilities of wireless telegraphy, are also very much discussed. The discussion is all the keener on account of the fall that has taken place in the value of submarine cable shares. Is this fall justified? Yes, reply the wireless telegraphists; no, say those interested either directly or indirectly in submarine cables. The journals interested endeavour to allay the panic. This is done with a good motive, and people undoubtedly impartial and not interested could not do otherwise. Is it not the duty of every physician to attend the sick, and of every man of feeling to help the mortally wounded? But *has* the submarine cable received its death-blow at the hands of wireless telegraphy? To answer this question logically, we must first ascertain whether this fall in cable shares is caused by *fears for the present* or by the *possibility of rivalry in a more or less distant future.* If the fall is caused by fears for the present, it is evidently not justified yet, at least, since wireless telegraphy has still to realise several desiderata, desiderata which, without any doubt, will be realised. They will be realised, for the past has clearly shown us that every scientific problem, once clearly stated, is half solved.

If, on the other hand, the fall is caused by the possibility of rivalry in a more or less distant future, it is perfectly justified.

Finally, if we admit:—(1) that wireless telegraphy has great possibilities; (2) that the fall is caused by the *possibility* of rivalry in the future; (3) that the fall is not justified; then there is only one hypothesis possible—*that the cable companies should themselves undertake wireless telegraphy.* Why not, if they find it more economical. Will the existing cables be renewed? That remains to be seen. Will wireless telegraphy be used for new installations? Yes, certainly, if it is found to be better. But is wireless telegraphy, or can it be, better than ordinary telegraphy? We are trying to show that it can. But that wireless telegraphy is more economical than ordinary telegraphy seems to us an axiom. The contrary seems a theorem incapable of proof, although it is given as the corollary of a demonstrated theorem, since all—even very competent experts, and we are far from claiming to be considered such, and only put forward our very humble opinion—urge that as electricity has not dethroned gas, so wireless telegraphy will not dethrone the submarine cable. In this argument there seems to us a very obvious error. It is a well-known fact that electricity possesses enormous advantages over gas. But if electricity has not dethroned gas, it is because electricity is more expensive than gas. Now, wireless telegraphy is less expensive than ordinary telegraphy, and if, as we believe, telegraphy without a conductor is better than the submarine cable, it is evident that it will supplant the latter, at any rate, for new installations. It has been pointed out to us that we have confused overland services with submarine cables. If we spoke of the price per km. for land wires (mean price 700 fr., but in countries like the Congo amounting to 3,000 fr.), it was because it seemed to us inadmissible that every km. of cable should cost 608 fr, that is, less than the land wires.

On looking into the figures, we find that *L'Electricien* has taken as dollars what should be pounds. The price per kilometre of cable thus resolves itself into

$$\frac{1,025,000,000}{200,000 \times 1{\cdot}852} = 2,767 \text{ fr.},$$

and the cable between Lizard Point and St. John's, Newfoundland (3,350 km.), would cost (taking into account the same considerations as before), 3,269,450 fr., instead of 2,036,000 fr., which confirms what we said before, that ordinary telegraphy costs much more—and with good reason—than wireless telegraphy. Mr. Ward has been reproached with going a little too far when he said that if the trans-Atlantic experiments in wireless telegraphy had been made sooner, it would not have been necessary to call upon the shareholders for the 107 million francs required for the Pacific cable.

Mr. Ward's language seems to us that of a conscientious man. Why, indeed, should 107 million francs be expended when the installation can *perhaps* be established with an expenditure of one million? in other words, if a dividend 107 times as great could be distributed among the shareholders with the cheaper kind of transmission? This is a question that affords scope for reflection, even now that all preparations are made for the laying of the Pacific cable. It cannot, perhaps, be said as yet that the expenses of laying a cable exceed those of the installation of a wireless telegraphy service, even if we take into account that the material ready for use can be utilised in other branches of human activity. I am quite of the opinion of Mr. Mervyn O'Gorman, that it is deeply to be regretted that the science is not where the capital is, or, what comes to the same thing, that the capital is not where the science is.

The coherer is destined to render great service in ordinary telegraphy, and especially in submarine cables. These services are of two kinds: (1) the coherer can be employed as a very sensitive relay; (2) the coherer can render multi-communication possible, *i.e.*, increase the efficiency of an existing cable. I will give further details on this subject.

With regard to the application of Hertzian waves to submarine cables, I wrote a note in the Electrical Review for January 18th, 1901. As regards the application of the coherer to ordinary telegraphy, I have already described applications in my Belgian patent of June 24th, 1899, and in my English patent of January 24th, 1900, No. 1,555 (this patent seems to be of universal application, but in reality, the arrangements described in it are based on one single idea).

In conclusion, therefore, we may say that there is a means of satisfying everybody, the shareholders and the cable companies on the one hand, and the wireless telegraphists on the other: *medium tenuere beati.*

We will ask the directors of the cable companies to be so good as to forsake routine for once; first to use ordinary telegraphy with a coherer and then wireless telegraphy with or without a coherer.

THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The resolutions passed on Friday last at the special general meeting of this Association seriously conflict with the opinions expressed in the sixteenth annual report of the Institute of Municipal Treasurers' and Accountants' (Incorporated) presented in July last at Kensington.

To see great men struggling with difficulties is said to be a sight for the gods, and to watch the contest between municipal traders, represented by town councillors against their treasurers, accountants and auditors, may be commended to ratepayers as an exhibition worthy of their especial attention.

In dealing with electricity supply, municipalities are encompassed with serious disabilities. It might have been supposed that the initial disadvantage of not knowing the business, nor possessing the capital to trade with, would have been sufficient to deter the representatives of struggling ratepayers from embarking in dangerous speculations; but, in addition to this, they are seriously handicapped by the terms upon which money can be borrowed on security of the rates, and the requirements of accountants and auditors with respect to the proper regulation of these accounts.

The three points dealt with by the Incorporated Municipal Electrical Association, on the 21st inst., were:—

1. The best means of obtaining an alteration to the existing regulations controlling the repayment of loans borrowed for the purposes of electricity supply undertakings, whereby local authorities are compelled to repay during the construction of works.

2. The desirability, or otherwise, of deciding the percentage which should be allowed for the depreciation of electricity undertakings.

3. The desirability, or otherwise, of recommending local authorities to form a reserve fund for the replacement of obsolete plant, and for other purposes specified in the electric lighting orders.

The resolutions passed with more or less unanimity, exemplified how much the wish is father to the thought, but will fail to convince any impartial critic of the soundness of the conclusions arrived at.

They are as follows:—

1. With reference to the resolution passed by this Association at the Glasgow Convention, 1901, authorising the Council to approach the President of the Local Government Board, and the Secretary of State for Scotland, with the object of obtaining leave to suspend the operations of sinking fund during the first three years of the loan and to take such further steps as may be necessary to accomplish the object, this meeting approves the action of the Council in approaching the Borough Treasurers' Association in order to ensure their co-operation, and unanimously agrees that the operation of sinking fund should be suspended for three years from the date of loan without, however, increasing the period allowed for repayment, and that this suspension should apply also to monies borrowed for the purpose of extensions from time to time.

In providing capital for carrying on a business, the principle of repayment cannot be regulated by any automatic system of returning the money to the lenders, whatever the results of the business may be; this is especially the case in an electric supply undertaking in which the natural growth of the enterprise necessarily involves a constant addition to, instead of a diminution of, the capital account.

If the profits earned are sufficient to pay a fair interest and a bonus equivalent to a return of capital, well and good, but otherwise the funds for carrying on the business must be permanent, and this is one of the disadvantages under which the local authority labours in trading entirely on borrowed money.

As it is, there is no uniformity in the terms under which loans for electric undertakings are obtained—in some cases the municipality issues stock, redeemable at long periods, in others the money is advanced by the London County Council for a longer time than is obtainable under the ordinary 25 years' system. The Croydon Corporation have just issued a 3 per cent. stock at £96 per cent., which runs until April 5th, 1960, and as this loan is to cover, *inter alia*, the construction of permanent works for electric lighting, the repayment will not be completed for 58 years. In Scotland the terms are about 50 years, but in all cases the principle of trading upon money borrowed, subject to repayment without reference to the exigencies of the business, is unsound.

Of course, the object of the Municipal Association is to postpone the unpleasant experience, which is practically universal, of having to make claims upon the rates owing to the trading being unprofitable, and thus render the local authorities unpopular; but next to avoiding such trading experiences altogether it would be better for those who have unwittingly entered upon the business to find means of transferring their undertakings to experts willing to relieve them of their white elephants.

By means of overdrafts from the bankers, the sinking fund is postponed until the permanent borrowing takes place, and the Local Government Board have generally overlooked the practice, but the borough accountant of Eastbourne in his paper read at the meeting of the Institute of Municipal Treasurers and Accountants, mentions that one Corporation has been threatened with a surcharge in respect of any payment of bank interest, and that care is taken to issue stock in advance of requirements, which may not always be convenient or economical.

Many local authorities indulge in what is described as the spendthrift policy of bank overdrafts to defer sinking fund payments, but, as Mr. Booth, of St. Pancras, warned the Association, this may lead some day to the introduction of Local Government audit, which, as a matter of fact, ought to be adopted in the interest of the ratepayers.

It was generally admitted that the system of borrowing from the bankers for capital expenditure was not legal, and that large and small corporations are equally sinners in this matter.

The second resolution of the Incorporated Municipal Electrical Association dealt with the question of depreciation in the following terms:—

That in the opinion of this Association, electricity supply undertakings having to be maintained in a thorough state of efficiency out of revenue, no depreciation or further writing off of capital is necessary when the period allowed for repayment of loans is not greater than 30 years, as the equated life of the plant exceeds that period.

It is satisfactory to find that at least three members dissented from this utterly unsound doctrine; but we leave the Institute of Municipal Treasurers and Accountants to deal with it (as they have done, by anticipation), by quoting their views on the subject at the meeting at Kensington in July, 1901.

In a paper read there by Mr. Arthur Towers, F.S.A.A., borough treasurer of Islington, he defines depreciation as "*the diminution of the intrinsic value of anything*," and states truly enough that with electric lighting machinery and plant there can be no *increment* of value; the argument that maintenance in a high state of efficiency out of revenue dispenses with the necessity for providing a depreciation fund only proves that the *object* of such a fund has not been clearly grasped.

He forcibly argues that, in the case of a limited company, it is a different matter, as the capital there forms a permanent loan; in fact, the concern *belongs* to the shareholders.

He contends that both a reserve fund to meet contingencies, and a depreciation fund, are absolutely necessary to all electric lighting undertakings, and he deprecates the practice of paying sums out of what are *called profits* to the relief of rates before a reserve and depreciation fund have been formed.

Opinions were divided in the discussion of Mr. Towers's paper, one dissentient giving away those advocates of the principle of no depreciation fund being necessary, when he naively suggested that it was a question of private enterprise *versus* municipal trading, and said he could quite see that if we can only be induced to make additional provision for the depreciation fund, it is quite possible that private enterprise may point to these undertakings of municipal authorities as being non-paying undertakings.

By this candid utterance the cat was deftly let out of the bag!

INSTITUTION OF ELECTRICAL ENGINEERS (BIRMINGHAM SECTION).

A meeting was held on Wednesday, February 12th, at the Municipal Technical School, to discuss Dr. Sumpner's two papers, read at a previous meeting, the first being a "Note on Alternate Current Diagrams," the second "The Testing of Motor Losses."

Mr. Housman criticised the second paper, but expressed the opinion that it showed a good method for testing large machines with big fly-wheels.

Mr. Henry Lea pointed out that it assumed that friction was constant at all speeds, which was not the case, and that for belt-driven machines it did not take into account the slip of the belt.

Mr. Taylor spoke at some length on the first paper, and stated that he had made some practical tests, and found that either he had not followed the meaning of "the phase angle between two lines," or else the statement made in the paper that the cosine of this angle multiplied by the product of the lengths of lines is equal to the average value of the product of the two quantities represented by the lines. He quoted the figures he had obtained, but Dr. Sumpner explained later that he had not read the paper aright. Dr. Sumpner also informed Mr. Housman, that he quite agreed that Kapp and Housman's method was the best for testing small motors, his was merely a workshop method for testing big machines with heavy fly-wheels, and such as could be used in any workshop or central station with the ordinary instruments.

Prof. Threlfall showed an electric furnace in which the arc took some 300 to 400 amperes at 100 volts. He showed how simply electric furnaces could be constructed, and showed some formed of lime. He also exhibited several interesting specimens of the metals obtainable only in that way, and some models of electric furnaces. The audience found it very necessary to protect their eyes from the intense glare by means of the coloured glass which was provided, and finally Prof. Threlfall succeeded in melting lime in his furnace, obtaining a temperature which he said was far above 2,000° F.—some one suggested that it must have been over 3,000° F.

Mr. Henry Lea moved a vote of thanks, which was accorded heartily.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1902.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London W.C., and at Liverpool, to whom all inquiries should be addressed.

3,299. "Improvements in brackets, pendants and like fittings for gas and electrical illumination." E. Townshend. February 10th.

3,336. "Improvements in electrical resistances." R. Hoffelt. February 10th.

3,350. "Improvement in telephone clips." C. W. Wroe. February 10th.

3,374. "An improved protective operating device for electric motors." J. Y. Johnson. (The Electric Controller and Supply Company, United States.) February 10th. (Complete.)

3,392. "An electric lamp suspender adjusting device." B. T. S. Bagnall. February 11th.

3,411. "Improvements in and relating to guards for electric tramcars and the like." Barry, Henry & Co., Limited, and R. B. Davidson. February 11th.

3,416. "Improvements in switches for electric light circuits and the like." J. Jones and J. Jones, jun. February 11th. (Complete.)

3,428. "Improvements in electric lamps and lampholders." P. J. S. Tiddeman. February 11th.

3,460. "Improvements in radiators." M. Shearer. February 11th.

3,490. "Improvements in lightning dischargers for electrical installations." Siemens Bros. & Co., Limited. (Siemens & Halske, Aktien Gesellschaft, Germany.) February 11th. (Complete.)

3,491. "Improved brush holder for electrical apparatus." Siemens Bros. and Co., Limited. (Siemens & Halske, Aktien Gesellschaft, Germany.) February 11th. (Complete.)

3,497. "Improvements in machinery for generating electricity." G. Earl-Adams. February 11th.

3,533. "Improvements in winding and circuit closing devices for electrically-wound clocks." C. M. Crook. February 11th. (Complete.)

3,603. "Improvements in means for conducting electricity from overhead cables to trams and other motors." G. H. Russell. February 12th.

3,608. "Improved manufacture of strands for telegraph and telephone cables." Siemens Brothers & Company, Limited. (Siemens & Halske, A. G., Germany.) February 12th. (Complete.)

3,609. "An improvement in governors for regulating speed, electricity, gas supply and like apparatus." C. A. Vigreux and L. V. Brillie. February 12th.

3,610. "Improvement in electrically propelled vehicles for single elevated railways." F. B. Behr. February 12th. (Complete)

3,622. "An improved device for cleaning and polishing electrical collectors." W. Kuppers. February 12th.

3,624. "Method for perfecting the fabrication of electric sparking candle." C. E. Osborn and The British Motor Traction Company, Limited. February 12th.

3,629. "Improvements in electric arc lamps." L. Wirtz. February 12th.

3,631. "Combined portable table stand and wall bracket for electric light." L. A. R. Wallace. February 12th.

3,647. "Improvements in or connected with open slot electric traction systems." J. C. Jackson. February 12th.

3,652. "An improvement in or relating to current collectors of tramway and railway cars run on the overhead system. P. R. Morno and J. M. Bowman. February 12th.

3,657. "Improvements relating to insulated electrical conductors." J F. Cummings. February 12th. (Complete.)

3,658. "Improvements in and relating to the fixing and carrying of electric cables, wires, and such like connections. A. Ford-Lloyd and C. Stirling. February 12th.

3,686. "Improvements in apparatus employed for electrically igniting the wicks of miners' safety lamps." W. H. Johnson and R. Marsh. February 13th.

3,737. "Improvements in electrical and magnetic apparatus, such as transformers, dynamos, and other appliances, and alloys for use therein." R. A. Hadfield. February 13th.

3,746. "Improvements in, and connected with, electric ignition devices for internal combustion engines." A. F. Spooner. (J. Duenet, France.) February 13th.

3,748. "Improvements in alternate current distribution." W. M. Mordey. February 13th.

3,751. "Improvements in and relating to electric arc projecting lanterns." F. H. Loring. February 13th.

3,788. "A point-shifting appliance for electric tramways fitted with overhead equipment." P. Graham. February 14th.

3,819. "Improvements in and relating to storage batteries." J. T. Niblett. February 14th.

3,859. "Improvement in and relating to electric switches, switch bases, and means for connecting the circuits to be controlled with the same." L. Sunderland. February 14th.

3,894. "Improvements connected with the use of electric glow lamps for occasional illumination." F. Brown. February 14th.

3,912. "Improvements in electric furnaces." P. L. T. Heroult. February 15th.

3,913. "Improvements in coherers for wireless telegraphy." J. H. Reeves. February 15th.

3,932. "Improvements in dynamo-electric machines and motors." H. F. Joel. February 15th.

3,938. "Improvements in and relating to the storage and distribution of electricity by means of accumulators." C. Wrede and H. Jungbluth. February 15th.

3,942. "Improvements in or connected with casings for electric conductors." H. Beau. February 15th.

3,953. "Improvements relating to telegraphic and telephonic apparatus." H. H. Lake. (Aktieselskabet "Progress," Norway.) February 15th. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1900.

9,844. "Improvements in incandescence electric lamps." B. M. Drake and Nernst Electric Light. Dated May 30th, 1900. Incandescent lamps. A filament made of rare earths is provided with heat-dissipating devices at the anode connection to prevent over-heating there. Both ends may be so provided, rendering the lamp independent of the direction of the current. The heat dissipators may be made by coiling the platinum connecting wires on the ends of the filament, leaving loops projecting radially. Each loop is twisted, and the coiled wire is covered with oxide paste, the twisted loops being preferably left projecting from the finished end. Or radiating plates or rods may be used. 3 claims.

9,855. "Improvements in transformer systems for current supply for electric railways." British Thomson-Houston Company. (W. B. Potter, U.S.A.) Dated May 30th, 1900. Electric railways and tramways worked with multiphase currents and transformers on sectional conductors. Cannot be abridged without reference to a diagram. 27 claims.

9,862. "Improvements in or relating to alternate current induction motors." G. W. Money. Dated May 30th, 1900. Relates to means for starting and controlling the speed of alternating current induction motors without the use of multiple contact switch arrangements. 4 claims.

9,971. "An improved method of utilising electrical earth currents." E. Jahr. Dated May 30th, 1900. Electrical earth currents are utilised by thrusting into the earth or into water in or on the earth two electrodes, of which the electro-positive one has a position to the north of and deeper than that of the electro-negative. 1 claim.

9,975. "Improvements in electrical transformers." R. Grisson. Dated May 30th, 1900. Two primary coils are caused to act upon two secondary coils, which are arranged in series, the current being sent through the primaries alternately by means of the commutators. 1 claim.

9,982. "Improvements in electric incandescent lampholders." E. G. Sheppard and Nernst Electric Light. Dated May 30th, 1900. A holder in which three contacts are to be made without possibility of wrong connection, has one central contact, the others being placed at unequal distances on opposite sides thereof The holders are especially applicable to Nernst lamps. 2 claims.

10,029. "Improvements relating to the distribution of electric current." H. W. Storer. Relates to means for maintaining a constant electromotive force in a branch circuit when that in the main is variable, or for raising or lowering the pressure in branch circuits. 3 claims.

10,065. "Improvements in automatic magnetic circuit-breakers." W. R. Lake. Dated May 31st, 1900. Relates to a magnetic circuit breaker. The bridge-piece is carried by an arm connected to toggle levers, and also fitted with pins sliding in slots in the frame. A supplementary contact is carried by a leaf insulated from the contact. The contacts are held on against the action of the spring by a catch controlled by the overload magnet. When the catch is released, the pin slides in the slot, and contact is first broken laminated copper contact, and finally at the carbon contact, thus minimising arcing. 22 claims.

10,071. "Improvements in automobiles." N. Kitsee. Dated May 31st, 1900. Relates to means for stopping the vehicle automatically upon the occurrence of any emergency. 5 claims.

10,074. "Improvements in electric brakes for railway cars and the like." F. C. Newell. Dated May 31st, 1900. Relates to braking systems for railway cars in which a special braking controller is provided independent of the running controller, which may also be connected to the braking circuit to control the brakes. 7 claims.

10,124. "Calling appliances for telephone switchboard." J. E. Kingsbury. Dated June 1st, 1900. Relates to that class of exchange systems in which a subscriber has answering jacks and calling signals on more than one board. 8 claims.

10,133. "Improvements in and relating to voltmeters." T. Duncan. Dated June 1st, 1900. The pressure between any equally distant points on two continuous current supply mains is measured by a voltmeter connection being made with one main at the distant point by a single wire or by earth connections there and at the voltmeter. 6 claims.

10,134. "Improvements in alternating current wattmeters." T. Duncan. Dated June 1st, 1900. Relates to energy meters. An instrument for measuring either true or apparent watts. 6 claims.